Technical Report No. 1

BOREAL FRINGE [illegible] OF MARSH AND SWAMPLAN[illegible]
A General Background Study

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Technical Report No. 1

BOREAL FRINGE AREAS OF MARSH AND SWAMPLAND
A General Background Study

By

John W. Morris

A Contract Between

Geography Branch, Earth Sciences Division
Office of Naval Research, Navy Department

and

University of Oklahoma Research Institute

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John W. Morris, Project Director

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Department of Geography
University of Oklahoma
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PREFACE

This project was undertaken with the idea of supplying a general background and a series of keys for photo interpretation work in the swamp and marsh areas along the southern edge of the Boreal Forests. It is hoped that this series of keys will be a contribution equal in value to those produced by the Arctic Institute of the Catholic University of America, and the Geography Department of Northwestern University.

No project of this scope can be the work of any one individual, since it must contain information that is included in several of the disciplinary fields. The project director is deeply indebted to all who participated actively and with interest in this work. Special thanks of appreciation are due Dr. Harry E. Hoy, Professor of Geography, University of Oklahoma, Norman, Oklahoma, for his excellent cartographic work, his valuable advice and assistance in the time of need and his general interest in all phases of the work; Mr. Glen E. Durrell, Director, School of Forestry, Oklahoma Agricultural and Mechanical College, Stillwater, Oklahoma, for his assistance in securing competent helpers in the early stages of forestry identification and for his field work and general interest in the project; and to Mr. Merle P. Meyer, School of Forestry, University of Minnesota, St. Paul, Minnesota, for his very excellent work in the preparation of keys within the areas selected for intensive study. Others who have also given of their time and experience, and without whose aid this

project could not have been completed, are Professor Nate Walker and Mr. Jackie C. Runyon of the School of Forestry, Oklahoma A. & M. College, Stillwater, Oklahoma; Don R. Hoy, William [illegible] Finch, Donald O. Clark and Bill Cox, all graduate students in the Department of Geography, University of Oklahoma, Norman, Oklahoma, who have worked long and faithfully with the project director both in the field and in the laboratory. Their suggestions have been of far greater value than they suspect. Mrs. June Duggin has typed and retyped the manuscripts. Her efficient work and calm attitude have aided all concerned.

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INTRODUCTION

The study of aerial photography and the interpretation of aerial photographs is rapidly becoming more widely used than at any previous time. Aerial photos present, in a compact form, views of the landscape that could be acquired only after months and even years of work in the field. The compactness of the photograph presents a living view which can be seen in third dimension when overlapping pairs are put under the stereoscope. In almost all cases a direct relationship exists between topography, drainage, vegetation and land use. Under such conditions, most cases of relationship are easily and quickly apparent to the trained eye.

The ideal photo interpreter would be one who has been trained in the fields of Geography, Geology, Forestry, Botany and Architecture. Since people with such a variety of training are not to be found, and since the best of the photo interpreters will be trained in only one or two of these fields, if he is fortunate enough to have training in any of them, the reports have been written in a semi-technical style. By studying Technical Report No. 1 and then following through as directed by the keys in the remaining reports, it is believed that the photo interpreter will be able to glean the necessary information to answer most questions about areas similar to those studied in the report.

Object of Research

I. The general objective of the research was to study aerial photographs,

maps, and climatic records of selected parts of the marsh, swamp and lake area of northern Minnesota, southern Ontario, and southwestern Manitoba (Lat. 46° - 50° N.) in order to determine key objects for photo identification purposes during the summer or foliage season, and for the winter or non-foliage season.

II. The specific objectives of the research were:

A. To develop seasonal keys - summer (foliage), winter (non-foliage) - to aid photo interpreters working in a boreal fringe area of bog, marsh and swampland. The keys are intended to aid in the determination of:

1. Relative location of the types and kinds of vegetation.
2. Trafficability conditions in various parts of such an area.
3. Possible concealment and clearing areas.
4. Construction materials available in the area.
5. Possible sources of food and fuel in the area.

B. To develop a series of maps and diagrams of such an area to aid with the interpretation.

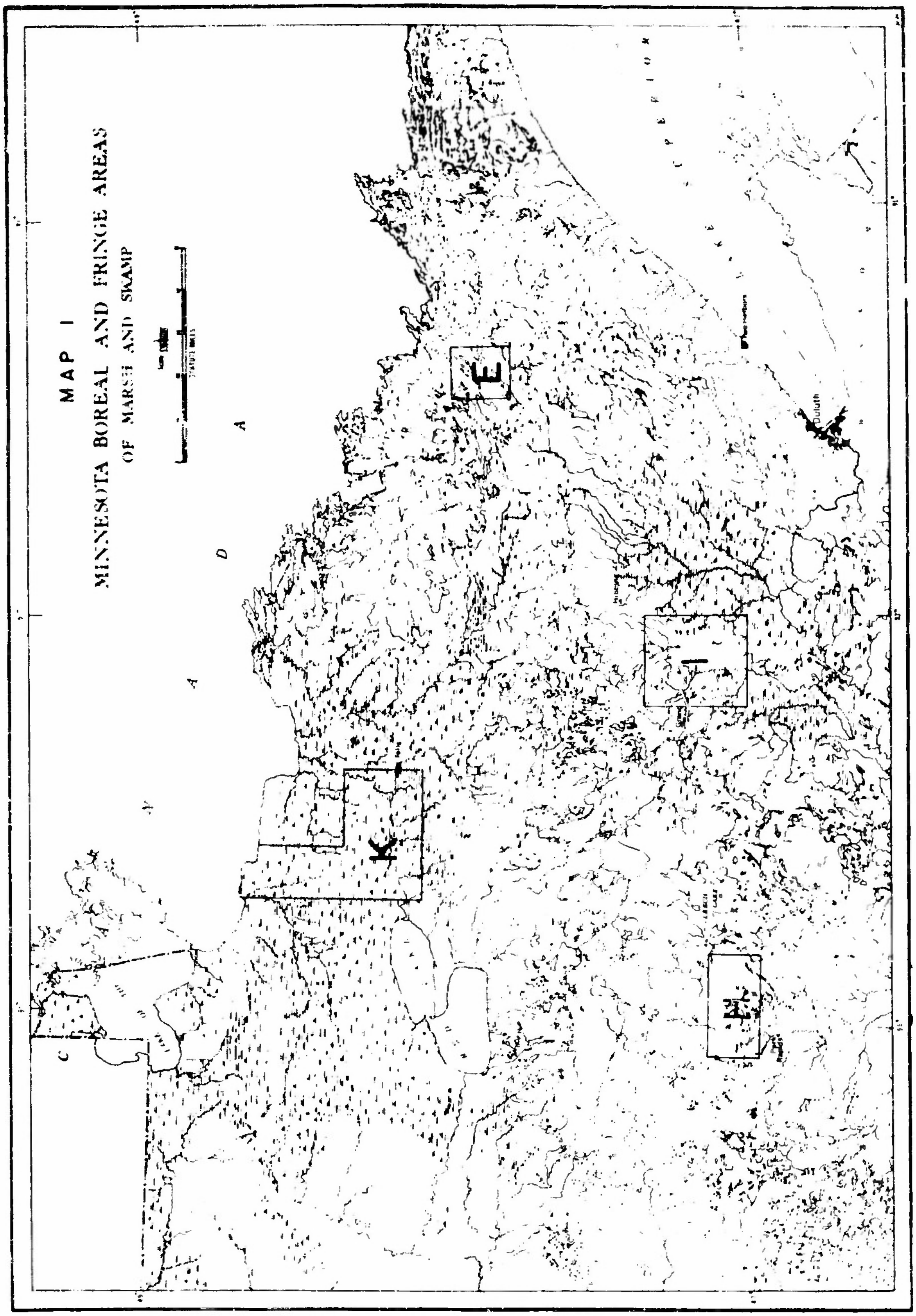
<u>Areas Selected for Study</u>

Due to difficulties in securing Canadian photographs the marsh, swamp, morainic and fringe area of the northern forests of Minnesota was selected to serve as the basis for this project. Four specific areas were studied in detail because of their geologic and topographic differences, and at the same time their vegetation and general cultural

likenesses. These areas are designated on Map 1 as follows: the Ely Area (E), the Hubbard Area (H), the Koochiching Area (K), and the Itasca Area (I).

The Ely Area (E) is located in the vicinity of the city of Ely in northeastern Minnesota (Map 1). This area is in the old Superior Highland section of the United States. The bedrock is exposed at the surface in many places and in most of the rest of the area is within a few feet of the surface (Fig. 1). Unusually large erratics, half exposed in the patches of glacial drift, are numerous. Boulders of all types and sizes can easily be seen in road cuts or plowed fields. In general, the lakes in the area are long and narrow, most of them extending in a general east-west direction. Numerous swamps and bogs of varying sizes occupy filled lake beds and shallow depressions. Roads are few, and settlements far apart. Most of the cultural development is along the lakes where recreational activities are important. Logging trails, many of which have not been used for several years, are visible. Much of the vegetation in the area is hardwoods.

The Hubbard Area (H) is located in the central part of Hubbard county, Minnesota (Map 1). It is an enormous moraine with kames and kettles, very rough and rugged (Fig. 2). Numerous kettles, small lakes, and filled-in lakes can be observed. Although this region also contains many boulders of varying sizes, none the size of those in the Ely Area were observed. Along the edges of the rugged area, and where highways have been cut across the moraine in a north-south direction, a few farms have developed. In general the topography is too rough, and in


MAP I
MINNESOTA BOREAL AND FRINGE AREAS
OF MARSH AND SWAMP
Duluth

many cases the soil too poor, to be used for crops other than grass. The moraine is covered with various types of trees, among them being pine mixed with aspen, birch and other hardwoods in the drier places. Around the edges of the lakes, and especially in the marsh or bog areas, can be found spruce and tamarack.

The Koochiching Area (K) is located in the eastern part of old glacial Lake Agassiz (Map 1). The topography of this region is in direct contrast with that of either the Ely or Hubbard Areas. The land is unusually flat and differences in elevation are small. With the exception of a few small "islands" the entire region is one mass of peat bogs and marshes. Black spruce and tamarack are the common trees of the swamp areas with pines occupying some of the highlands or islands (Fig. 3). In the early part of this century, an attempt was made to drain the area with the hope that the land could be used for agricultural purposes. Many hundreds of miles of drainage ditches were dug. These ditches crossed each other at two-mile intervals. Thus, on the photographs, a definite pattern of what appears to be roads is easily seen. Because of vegetation conditions little drainage has taken place. Some water stands in the ditches. Since the project has long been abandoned, beavers have built dams across these ditches, thus they actually no longer serve to drain the area. Due to both poor construction and the natural physical features, the project was never successful. With the exception of a few places along the rivers, where the land is well enough drained for agricultural activities, the area is largely uninhabited. In such an area, road construction is almost an impossibility,

except at unusually great costs.

The Itasca Area (I) is in many respects a common meeting ground of the above three types of areas (Map 1). A portion of the moraine region such as is found in Hubbard county joins some of the prongs of the old Superior Highlands, and in close proximity to both of these are large former lakes which have in them large areas of bog and marsh land (Fig. 4). Large boulders, in some cases comparable to those found in the Ely Area, can be seen. Rock fences built from glacial rocks are common. Roads follow no definite north-south or east-west lines, but wind hither and yon as necessary for the best construction. The vegetation of the area varies all the way from lowland brush and cattails, such as are common in the Koochiching region, to the aspen and various types of hardwood found in the Ely and Hubbard Areas. The Itasca Area has more developed farmland than any of the other three because of the variation in geological conditions and the improved soils.

Problems

The accomplishment of this study presented many problems. To make a photographic key that is useable under any and all conditions is almost an impossibility. Differences in photography, in the time in which the photography was taken - both seasonal and daily - plus differences in the kind of film used, different methods in the development of the film, and above all, the training of the interpreter himself, must be considered. The background of experience, and the general knowledge of the interpreter of the area or region to be studied, are of primary importance in the recognition of geographic features, geologic

features and vegetational features shown on an aerial photograph. The photographic appearance of all elements will depend to a large extent, not only on the topographic situation, but also on the time of day and the season of the photography. Generally, fall or spring photography is unreliable and unsatisfactory except when a relatively small area can be photographed under ideal conditions. In vegetation identification fall photography is preferable to that taken in the spring.* The scale of the photography is also of primary importance.

From all photographs, however, a few general ideas can be gained. For example, topographical features are best recognized by shape and dimension. Railroads can usually be recognized by their numerous cuts and fills, their general gradient, and the fact that secondary roads avoid or cross them rather than join them as they would a main road. Usually buildings are of a distinct shape and several of them can be classified as to use by shape and location. Under the stereoscope, lakes, streams and ditches, as well as other land forms are quickly recognized in their third dimensional form.

The interpretation of cover type vegetation employs many factors such as texture, tone, shade, and location. Tone varies from white through all shades of gray to black. Vegetation items such as upland grass, broad leaf trees, and such cultural items as roads and gravel pits are usually light in tone. Water, coniferous trees and rough pastures are generally dark in tone. A notable exception must

*Stephen H. Spurr and C. T. Brown, Jr., "Specifications for Aerial Photographs Used in Forest Management," Photogrammetric Engineer, XII (1946), p. 133.

be made, however, with water. If it is photographed at such an angle that the sun's reflection strikes the camera lens, the results are white tones (Fig. 5). During the fall season tamarack leaves will also give white tones.

Texture also plays a very important part in interpretation. It varies from coarse to smooth. Fields, meadows, and roads are generally classed as smooth in texture. Small trees, seedlings, and muskeg are usually very finely textured. Dense stands vary from medium to fine texture.

The problem of shadows can be a great help or hindrance to the photo interpreter, depending upon his knowledge of the area and objects under consideration. Many objects, such as water tanks, radio towers, lookout towers, power line poles, and buildings, can be recognized from shadows alone. By using the shadows actual heights can be determined, if it is found necessary.

Methodology

The methodology used for this and the succeeding reports was as follows:

(1) The area was visited to determine just where the best contrasts could be studied, and at the same time to find areas that were typical not only of this part of the United States, but other parts of the world.

(2) After the selection of the four areas was settled, an attempt was made to find the types and kinds of aerial photography that had been flown. After this photography had been acquired, scales were determined and maps constructed.

(3) Complete photographic coverage for the four type areas, for each season, was requested through BuAir. NAS Minneapolis was ordered to make the flights as a part of their training program.

(4) Maps of land forms, geologic features, vegetation cover, and cultural features were made or acquired. The maps were correlated with each other and with the photographs.

(5) An interpretation to determine the generalized features was made by the group at the University of Oklahoma. Specialized keys were made by personnel in the Forestry Department at Oklahoma A. and M. College and in the School of Forestry at the University of Minnesota. The specialized keys were then correlated with the general keys and maps that had been acquired and developed.

(6) Field trips into each of the four areas were made in which the keys and maps were ground checked from actual observation within the areas.

(7) Numerous interviews have been held with road contractors, foresters, county supervisors, loggers, and others who could give assistance as to the various types of conditions in and around the areas being studied, as well as supply general informational background for the study in general.

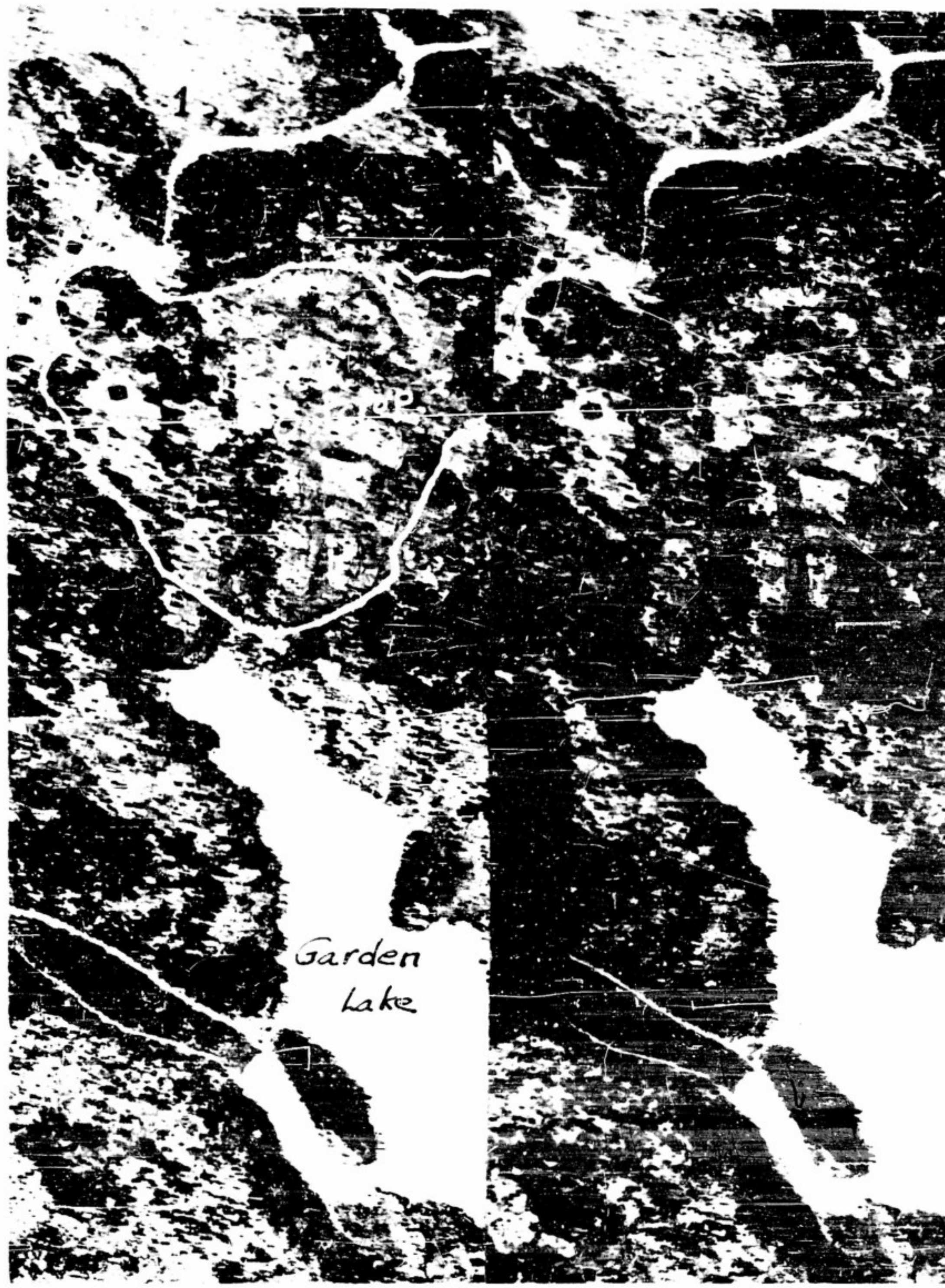
(8) Both infra-red and panchromatic pictures have been used in Report 1. The scales on the photographs vary from approximately 1:6,000 to 1:20,000. For Reports 2 and 3 only panchromatic photos were used. Different kinds of photography and different scales are used to show contrasts. Numerous stereo ground photos are used to illustrate specific points.

Reports

In addition to this report (Technical Report 1), two reports of specific seasonal keys will be prepared. This report attempts to acquaint the users of the keys with the types of physical, cultural, climatic, topographic and vegetational features of swamp and marsh lands along the southern edge of the Boreal Forest. The photo interpreter, to understand and use the keys in the most effective manner, must know as much as possible about the areas for which they are made.

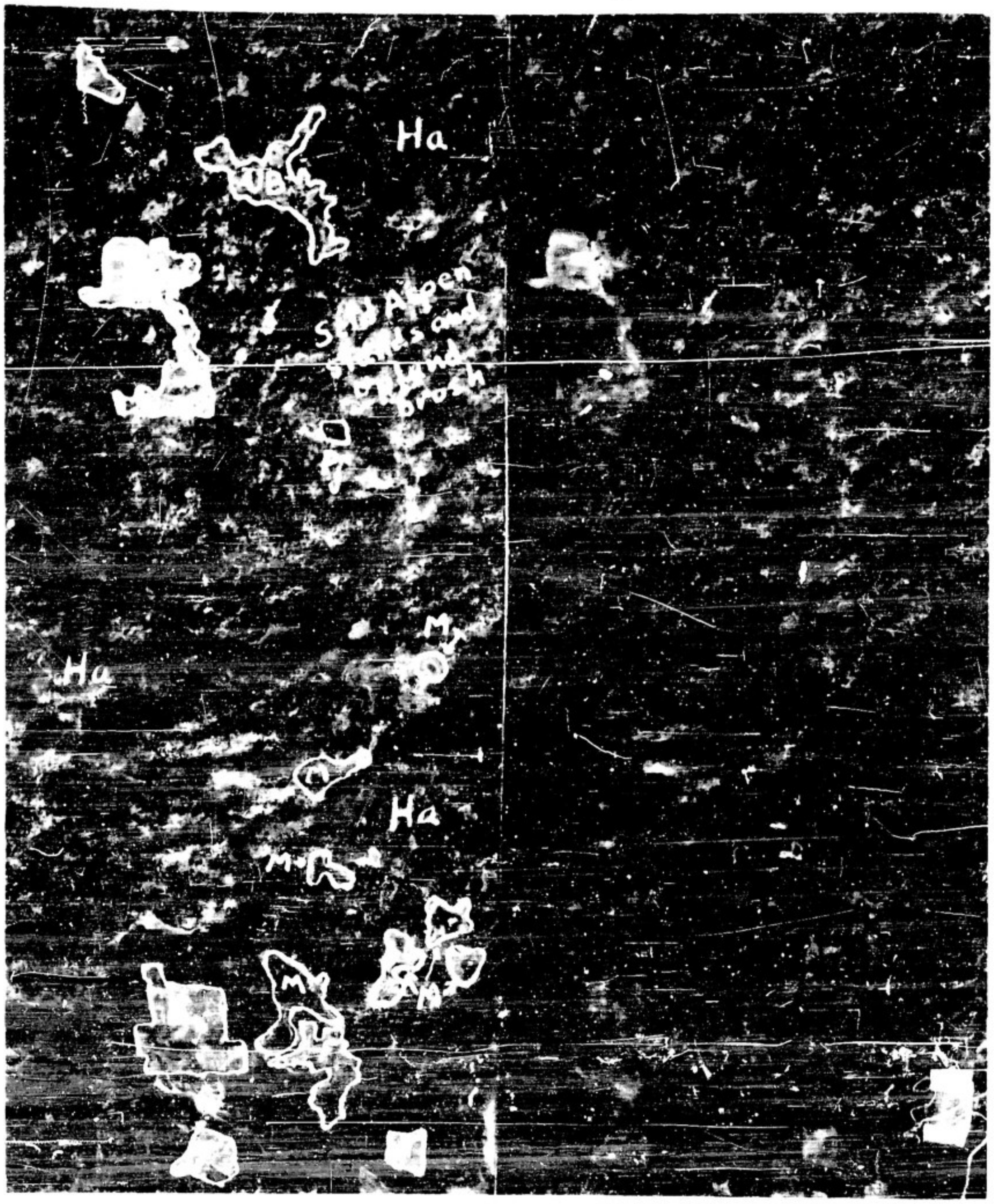
Technical Report 2 - Keys for the Summer (Foliage) Season

Technical Report 3 - Keys for the Winter (Non-foliage) Season



Scale 1:7,500

Fig. 1 - ELY AREA. Rock outcrops are common in this area. They may be either large or small, and relatively smooth or very rugged. Many barren spots may be present due to shallow soil. These conditions are easier to detect on winter than summer photographs. In winter photos lakes are white due to snow and ice covering. A good example of a winter road (1) is shown.



Scale 1:20,000

Fig. 2 - HUBBARD AREA. This figure is typical of the terrain in a terminal moraine area. Irregular ridges, numerous kettles with small lakes, or marshes (M), or both, occupying parts of the depressions, and irregular areas of farm land (F) are characteristic. Areas of upland brush (UB) are often mixed with the denser tree growth. In the Hubbard Area hardwoods form almost all the forests with Aspen (Ha) being the dominant tree. Small areas of Jack Pine (Pj) may also be present.

Scale 1:20,000

Fig. 3 - KOOCHICHING AREA. The Koochiching Area is in that part of Minnesota which is commonly referred to as the great Beltrami Swamp. At one time all of it was a part of Lake Agassiz. As a result the entire area is nearly flat and practically all vegetation indicates a region of high moisture content. Stagnant Spruce (Sx), Spruce (S), Tamarack (T) are all indicators of swamp type areas. Drainage ditches (1) were dug in an attempt to drain the area. Along the edges of the drainage ditches where the moisture content is lower, Aspen (A) often grows. Old beach lines (3) are identifiable because of the difference in vegetation. Game trails (2) show the easiest paths in which to cross such an area.

Scale 1:15,840

Fig. 4 - ITASCA AREA. Infra-red photos are used along with panchromatic to show the difference in tone and texture between these two types of films. In the Itasca Area the topography may range from relatively level to rough. Most depressions are filled with lakes or swamps (Sw). Frequently the connections between the lakes are marshy (M), especially when small streams flow from one lake to the other. On the higher area between the lakes, hardwoods (H) and Pines (P) will be found occupying much space. However, brush (Br) may occupy lands that have been cleared and are in the process of returning to forests. Trails (1) and logging areas (2) are the result of cultural factors within the area.

Scale 1:10,000

Fig. 5 - ITASCA AREA. This stereo pair is an excellent example of contrasting tones on adjacent photographs. Note that water ranges all the way from deepest black to white. The roads and a gravel pit appear white on each photo. Vegetation tones grade from black through the light grays. The darker tone of the conifers, as shown by the Spruce (S), over the deciduous, as shown by the mixed hardwoods (Hm), hardwoods with Aspen dominant (Ha) and Aspen (A), is apparent in both photographs. The higher farm land (F) and the area of stagnant Spruce (Sx), may be confused, however the heights of the land should be a factor in determination as well as texture and tone.

Chapter II

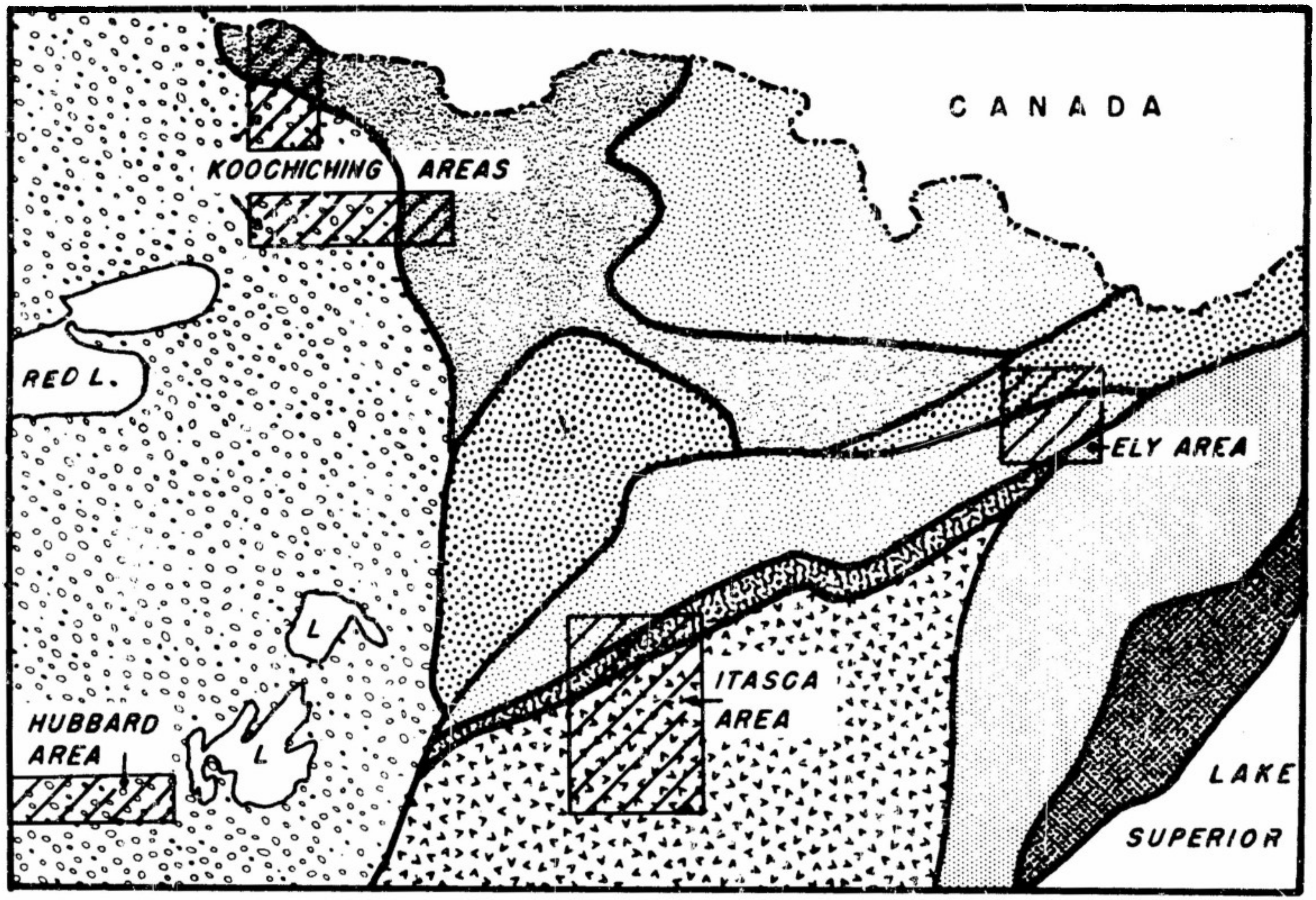
THE PHYSICAL ENVIRONMENT

In order to understand and to interpret aerial photographs, the photo interpreter must have as complete a knowledge as possible of the physical factors of the area involved. Should it be impossible for the interpreter to have reference materials that he can read, he must then depend upon maps which would show the relative conditions of such items as topography, drainage, and site.

The mere knowledge that a place is rough and rugged or smooth is not enough in itself. The interpreter should try to find out the reason why in each case. A hill area in a glaciated region may be composed of fine materials mixed with large erratics as is often found in moraines, or it may be composed of solid rock with a very shallow layer of soil (Fig. 6). The fact that an area appears to be level in a photograph is not in itself sufficient justification to say that transportation routes could be built easily and quickly across it. Thus, it is absolutely essential that the photo interpreter have as much supplementary intelligence material available as possible. Photo interpretation is a technique to aid in finding out what is in a region, not a panacea that will answer all of the questions simply because one has stereographic pairs available.

Geology and Topography

The geologic history of the part of Minnesota used in this report reaches back to the beginning of time (Map 2). Long before the state was covered by the great ice sheets it was a series of barren uneven



Map 2- AREA LOCATION AND GEOLOGY

KEWEENAWAN- DULUTH GABBRO

KEWEENAWAN- FLOWS & INTRUSIVES

UNDIFFERENTIATED ANIMIKIAN & OLDER

ANIMIKIAN SLATES

ALGOMAN GRANITE

LOWER-MIDDLE HURONIAN

PRE-CAMBRIAN IRON FORMATION

KEEWATIN ELY GREENSTONE

granite ridges. Some of this oldest known rock is exposed in Jasper Peak near Soudan (Ely Area). Upon this foundation was deposited great volcanic flows. Later mountain building and the great seas of geologic time changed the face of the land. Upon these old lavas, granites and altered sediments, the present surface of the area has been formed (Figs. 7 and 8).

During recent geologic time the activity has occurred which gives the Minnesota landscape its present familiar characteristics. From the north came the four ice invasions which covered northern Minnesota.

> Down the valleys moved [illegible] irresistibly scouring rock ridges, polishing knolls, breaking off and shoving boulders about, unloading tons of soil, and, as it melted, leaving heaped-up debris in the form of innumerable moraines to dam up ten thousand lakes.*

The first of the ice invasions, the Nebraskan, covered almost all of Minnesota and left over it a layer of gray drift. After an iceless interval a second, though less extensive, ice sheet followed. It, too, deposited a gray covering of soil forming materials. The third ice invasion, the Illinois, entered from the northeast. Its remnant is a layer of bright [illegible] which, in some places, is covered only by its own weathered topsoil. The fourth ice invasion came in three lobes. The Patrician glacier, moving down from the north of Lake Superior, brought with it a gray film of materials which it mixed with some of the iron rust of the ancient iron ranges. The Keewatin glacier came from the northwest along the Red and Minnesota River valleys and pushed broad lobes eastward.

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*Federal Writers' Project, Minnesota, (New York, Viking Press, 1938), p. 13

The Labrador glacier pushed through the Lake Superior basin toward the west to deposit loads of pinkish drift. The Patrician came into Minnesota earlier than either the Keewatin or Labrador and had receded before they put down their deposits.

The retreating glaciers left Lake Agassiz. Until the ice blocking the northward drainage of Red River had melted away, this large lake occupied the northwestern part of Minnesota as well as adjoining areas.

Map 2 is a generalized map showing the surface geology of northern Minnesota at the present time. The special areas being considered in this report are indicated thereon. It will be noted that the Hubbard Area, the region of sandy moraines, is in the undifferentiated Animikian and Older. The part of the Koochiching Area that was formerly covered by Lake Agassiz is also in this same geologic region. The northern and eastern parts of the Koochiching Area, however, are in the Lower-Middle Huronian. Although parts of both the Koochiching and Hubbard Areas are in general in the same type of surface geology, the topographical and present day physical aspects of them are completely different.

The Itasca Area is largely within the Animikian Slates, however, the northern section of the region being used is crossed by the Keweenawan-Flows and Intrusives and the Algoman Granite. The Ely Area also has three different geologic situations, namely the Keewatin Ely Greenstone, the Algoman Granite, and the Keweenawan-Duluth Gabbro. The differences in the present topographical features are readily apparent from the photographs that are used in the later chapters of the report. These

basic topographical differences, however, are largely a result of the geological formations upon which they are formed.

The topographic features are largely the result of glaciation. In many places it has been modified by the subsequent action of lakes and streams. In many places depressions were scooped out that now form lakes. Enough fine material was left among the exposed rocks and boulders to form a soil that would support a forest. In other places the drift was deposited in a system of hilly moraines and undulating intermorainic till plains (Fig. 9). Many small basins were formed among the morainic ridges, knolls and till plains as well as on the outwash, giving origin to thousands of lakes. Many have since been filled and/or drained by stream action.

The greatest relief in the regions being studied appears in the Ely Area. Bluffs rise abruptly from many of the lakes. The Koochiching Area has the smallest amount of local relief. Elevations over the areas range, generally, from 1,000 to 1,500 feet above sea level.

Climate

The climate of the southern edge of the Northern Boreal Forests areas in Minnesota and most other similar parts of the world is classed as the humid continental type, short summer phase. Climate is of tremendous importance, not only in the type of vegetation that is grown, but also in its effect upon the soil. Temperature conditions, the amount of sunshine, the dates of the first and last killing frost, as well as the total yearly precipitation and the distribution of precipitation throughout the year are all of importance to military personnel.

Especially important in this area is the number of days that the soils and bodies of water are frozen deep enough to support all kinds of transportation. In the Boreal Forest areas much of the seasonal activity depends upon the condition of the ground which in turn depends directly upon climatic factors.

Within the type areas used in this report the average January temperature varies from 1.6°F. at Baudette in the Koochiching Area to 7.4° at Cass Lake in the Itasca region (Table 1). The average temperatures do not indicate the real degree of coldness. Temperatures as low as -59° have been recorded at Pokegama Falls and Leech Lake Dam, both in the Itasca Area. All areas have recorded temperatures of -45° or lower. During the past year, when the winter field work for this series of reports was in progress, much of the work was done in temperatures ranging from a -15° to a -27°.

The average temperatures for the summer indicate a mild type of climate, since all the stations in the type areas report averages varying between 66° and 77°F. The maximum temperatures recorded, however, indicate that certain days can have exceedingly hot temperatures. Both stations in the Hubbard Area have had maximum temperatures of 107°. All stations within the area have recorded temperatures of 103° or higher.

The range of temperatures between the January and July averages varies between 60° and 66°F. The variation between the extremes shows a much greater contrast, ranging between 148° and 163°. It must be kept in mind, however, that this extreme variation is not based on

Table 1 - Temperature Record

Area	Station	Jan. Avg.	July Avg.	Maximum	Minimum
Ely	Meadowlands	6.1	66.6	103	-51
	Virginia	6.8	66.8	103	-45
Hubbard	Bemidji	4.7	68.9	107	-48
	Park Rapids	4.4	68.6	107	-51
Koochiching	International Falls	3.0	67.5	103	-49
	Baudette	1.6	67.4	103	-49
Itasca	Cass Lake	7.4	69.2	106	-46
	Leech Lake Dam	4.9	67.4	104	-59
	Grand Rapids	5.0	67.8	104	-51
	Pokegama Falls	4.3	66.2	103	-59

Source: Yearbook of Agriculture, 1941, Climate and Man

temperatures within a single year but upon temperatures the past 40 years. It is not unusual, however, for any have temperature extremes that vary as much as 100°. T personnel in such areas must be equipped with clothing both arctic and sub-tropic wear.

In general the total rainfall in each of the repo between 21 and 28 inches per year (Table 2). The thre July, and August are, almost without exception, the th months. During this period of time most of the sta tween 45 and 50 per cent of their total yearly rair had on the average approximately 2 inches more rair any of the other stations. The smallest yearly rai corded in the northwestern part of the Koochiching casionally will rainfall be so heavy in any particu will slow transportation facilities.

The total amount of snowfall ranges from 37.9 on the northern edge of the Hubbard Area, to 59.1 i the Ely Area (Table 3). Usually, June, July and Au snowfall, however, traces have been recorded during Tower and Winton Stations. Some snowfall has been tions during May and September. The period of grea from November through the middle of April. The Ely its elevation, generally has a greater total snowfa areas although it does not exceed them by a large a winter season snowfall may cause considerable diffi

Itasca	Cass Lake													
	Leech Lake Dam													
	Grand Rapid													
	Pokegama Falls	.55	.51	.95	1.58	2.88	3.60	3.30	3.35	3.00	1.93	1.24	.68	23.57

Source: Yearbook of Agriculture, 1941, Climate and Man.

Table 3 - Snowfall Distribution
(Inches and tenths)

Area	Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Ely	Tower	7.9	8.6	10.5	3.9	.6	T	.0	.0	.2	1.1	8.0	8.2	49.0
	Winton	10.7	8.9	12.6	6.0	T	T	.0	.0	T	2.8	7.5	10.6	59.1
Hubbard	Bemidji	8.2	6.2	7.3	2.4	.4	.0	.0	.0	T	1.5	3.4	8.5	37.9
	Park Rapids	6.6	6.3	7.6	5.1	.9	.0	.0	.0	.1	2.0	5.6	6.5	40.7
Koochiching	International Falls	10.4	9.2	8.7	1.6	.2	.0	.0	.0	.1	2.0	6.5	9.6	48.3
	Baudette	9.8	8.2	9.6	2.6	.4	.0	.0	.0	T	4.1	9.7	10.5	54.9
Itasca	Cass Lake	8.4	6.6	4.9	2.5	.2	.0	.0	.0	T	1.5	4.6	8.4	37.1
	Leech Lake Dam	9.7	8.6	9.5	3.6	.7	.0	.0	.0	T	1.7	6.6	8.9	49.3
	Grand Rapids	7.7	9.7	7.2	2.6	.3	.0	.0	.0	T	2.4	4.0	3.8	42.3
	Pokegama Falls	8.3	7.1	9.0	3.6	.5	.0	.0	.0	.1	1.8	6.3	8.3	45.0

Source: Climatic Summary of the United States, 1930, Section 44 - Northern Minnesota

if there is a strong wind at the time and drifts are formed. Snow cover is also a handicap in that it may prevent the freezing of the ground as deeply as is desired. In those areas where the lumber companies expect to make trails during the winter the snows are graded off to one side as soon after they fall as possible, thus permitting the ground to freeze deeper, harder, and quicker.

In all regions of the humid continental type of climate one of the most important factors is the succession of high and low pressure areas that commonly sweep from west to east. The disturbances in the Rocky Mountain area and northwestern Canada which are carried eastward across the United States are succeeded by the cooler polar air masses of the anticyclones. This results in alternating periods of heat and cold, of clear skies and rainy weather. The cyclonic control of the Minnesota climate, and of other similar climatic areas, makes these regions of changeable weather stimulating and invigorating.

<u>Rivers and Lakes</u>

A close study of the area reveals that many rivers and streams which are themselves very small often occupy valleys of large size. Lakes are not infrequently connected by streams during the season of high water and separated by swamps or marshes the remainder of the year. Water may flow through a channel from one lake or depression to another at one season and in the reverse direction at another season. A stream may take its origin in a high plain and flow away and disappear upon or in a swamp or marsh. A river may flow in a given direction for many miles, then make an abrupt turn, flow in a widely different direction

and perhaps double back upon its own course. The St. Louis River meanders through a marsh for many miles and then suddenly plunges down into Lake Superior. The Mustinka River flows in an eccentric course going first due south, then later as the Bois des Sioux to the north. Rum River starts south from Mille Lacs and turns abruptly east and north, away from its probable course to the Mississippi, via the St. Francis and Elk. The Mississippi River is said to have its source in Itasca Lake, yet both Itasca Lake and Lake De Soto and others, and beyond these the ultimate source of the river, is lost in a labyrinth of marshes and swamps, so that a single source cannot be accurately determined.

The region contains headwaters of three major drainage basins, one part draining north into Hudson Bay through the Red River and the Rainy River. Another drains south and to the Gulf of Mexico via the Mississippi, and a third drains east to the Atlantic through Lake Superior and the St. Lawrence River. In general, water sheds are inconspicuous and have relatively little effect upon the vegetation conditions or ordinary economic activities.

Map 1 shows the unusual drainage conditions as indicated by the vast number of swamps and lakes present. The lakes in themselves have definite characteristics. In the Ely Area most are elongated and extend in a general northeast-southwest direction. These lakes are, for the most part, the result of glacial erosion. However, a few were caused by glacial deposition. All the lakes in the Ely Area, and similar regions, have been classified by Zumberge into three types as follows:*

*Zumberge, J. H., Lakes of Minnesota (Minneapolis, University of Minnesota Press, 1952) p. 79.

1. Bedrock basins localized by preglacial valleys.

2. Bedrock basins not related to preglacial valleys.

3. Bedrock basins partially dammed by drift.

Many of the lakes in the region are connected by short rivers which in themselves appear to be a part of the lake.

In the Hubbard Area, most of the lakes are small and often circular in shape. Many of them are formed in the old glacial kettles. In the Itasca Area the lakes are both elongated and circular depending to a large extent upon the geology of the area in which they are located. The lakes in both these areas were largely the result of concentrated deposition of drift during extended pauses when the glaciers retreated.

The poorest drained of the four regions being studied is the Koochiching Area. This region, lying on the eastern edge of old glacial Lake Agassiz, is unusually level, the greatest variation in elevation being not more than 100 feet. Under present conditions much of Koochiching, Beltrami, and Lake of the Woods counties are of no use to mankind so far as agriculture production, road building, and general economic activities are concerned. Although drainage ditches were dug across this vast swamp area, they did not carry a sufficient amount of water to make it practical to use the land. The Koochiching Area is practically devoid of lakes except for a few ox-bows along the rivers. The absence of lakes is due to the fact that the sediment deposited by Lake Agassiz has almost completely filled all depressions that might otherwise become lakes. The three principal lakes that are remnants of Lake Agassiz within the area being studied are the Lake of the Woods,

Nett Lake and Red Lake. They have all been classified as pre-glacial lakes and are considered very temporary features. These lakes, especially Red Lake, are very shallow and silting rapidly.

In general, along the edges of the Boreal Forest, especially those places that mark the various advances of the glaciers, swamps and lakes are a common characteristic. It is these same swamps and lakes that present such a difficult problem to transportation.

Soils

The productiveness of soils depends largely upon the drainage conditions. A soil of clay or clay loam over gravel or loose sand suffers in time of deficient rainfall, while in wet season a soil resting upon heavy clay may be drowned unless surface drainage is perfectly adjusted. Soil underlayed by limestone or by till consisting of a light clay or a heavy loam will stand a greater variation in rainfall and still be highly productive.

The condition of the soil depends to some degree upon the character of the vegetation which has covered it. In prairie districts there is a more uniform exposure to weathering agencies than in forest districts. Consequently, there is a more uniform soil developed on a given deposit. On the whole, leaching of lime seems to be less rapid on prairies than in forests so that in the newer drift lime is often present near the surface in prairies but in the forest areas lime is usually leached to a depth of several inches below the surface. On the older drift the limestone is generally removed to a depth of several feet both in the prairie and in the forest areas, but the leaching is still deeper in the

forests. The rate of erosion and the removal of soil is more uniform in prairie than in forest tracts. Erosion in the forests is likely to be concentrated in occasional gullies whereas on prairies there are many small channels developed on every hillside which serves to break the soil down rapidly. On the whole, erosion is greater but leaching is less in prairies than in forested areas.

> In general plants are rather impartial as to soil unless the soil character is of an extreme type; relatively few have absolute soil requirements. Competition among forest trees may drive out some species, in which case the unsuccessful species cannot be described as incapable of growth on the soil from which they are driven; simply their competitors are able better to use the given resources of the soil and air.*

Each type of glacial topography in a glaciated country has not only its own distinctive slopes but also its distinctive soils. A map of the glacial forms of a region is therefore to a large extent a soil map of the region. Terminal moraines are noted for their stony till, outwash plains for their porous, gravelly, stratified, alluvial nature, eskers for their cobbly material, and kettle and kame topography is marked by sandy hillslopes and undrained hollows with soils largely of organic nature.

*Bowman, Isaiah, Forest Physiography, (New York, John Wiley and Sons, 1911), p. 2.

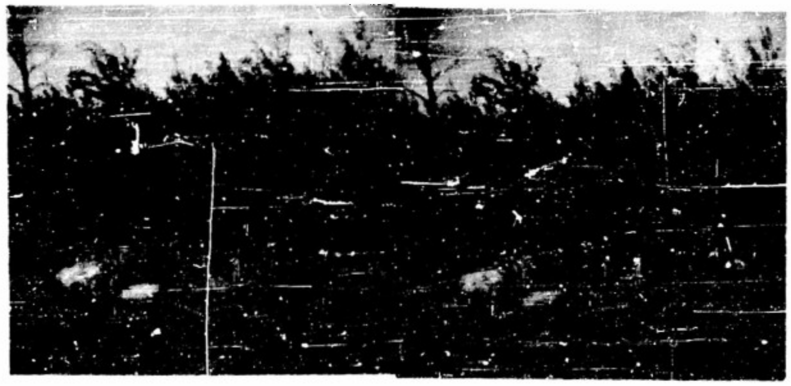


Fig. 6 - The landscape 3.5 miles north of Ericksburg. The boulders are a result of glaciation. They are a typical part of the landscape along the southern edge of the Boreal Forest.

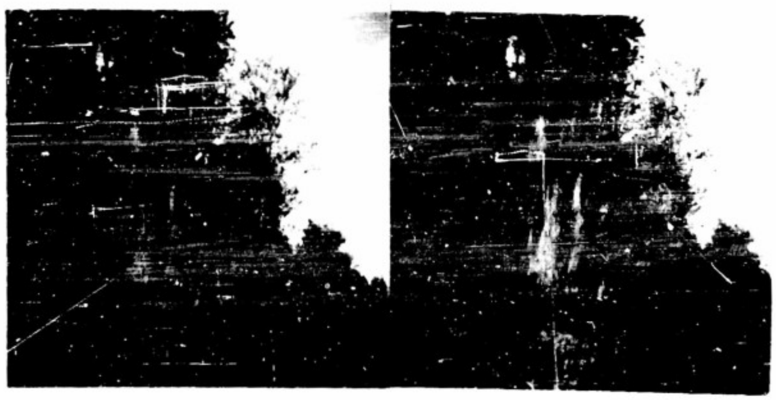
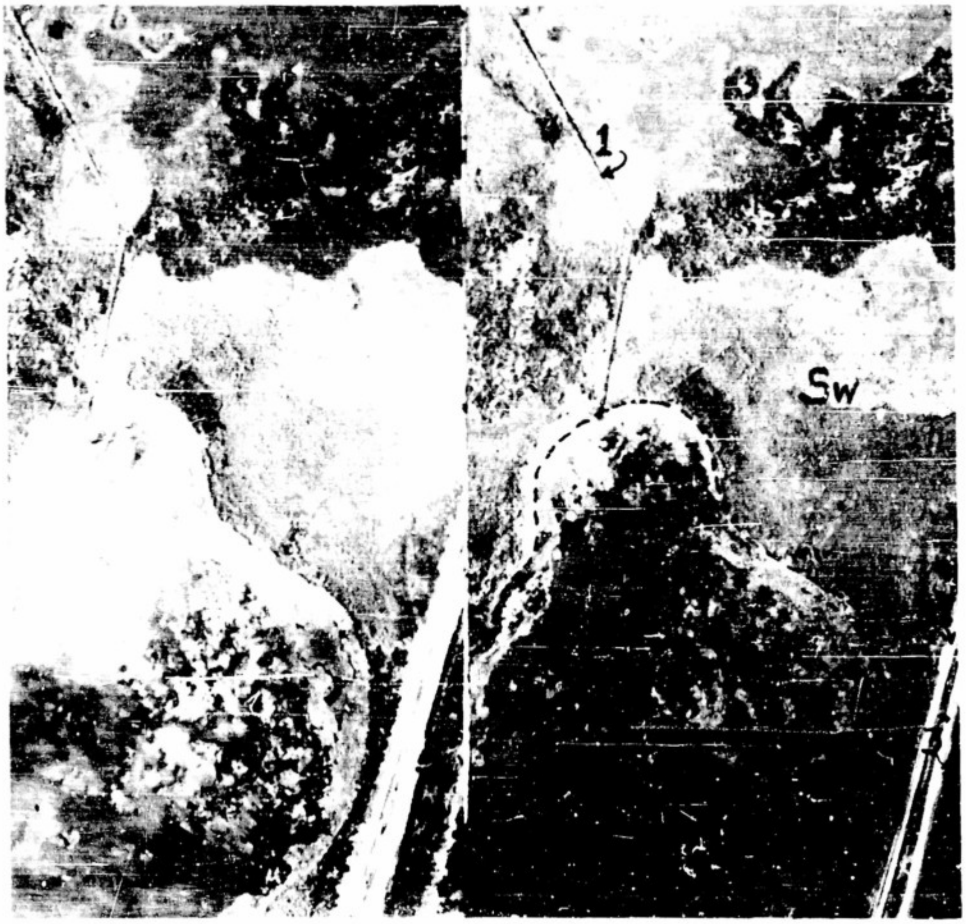


Fig. 7 - Metamorphosed material 14 miles south of Sioux Narrows, Ontario.

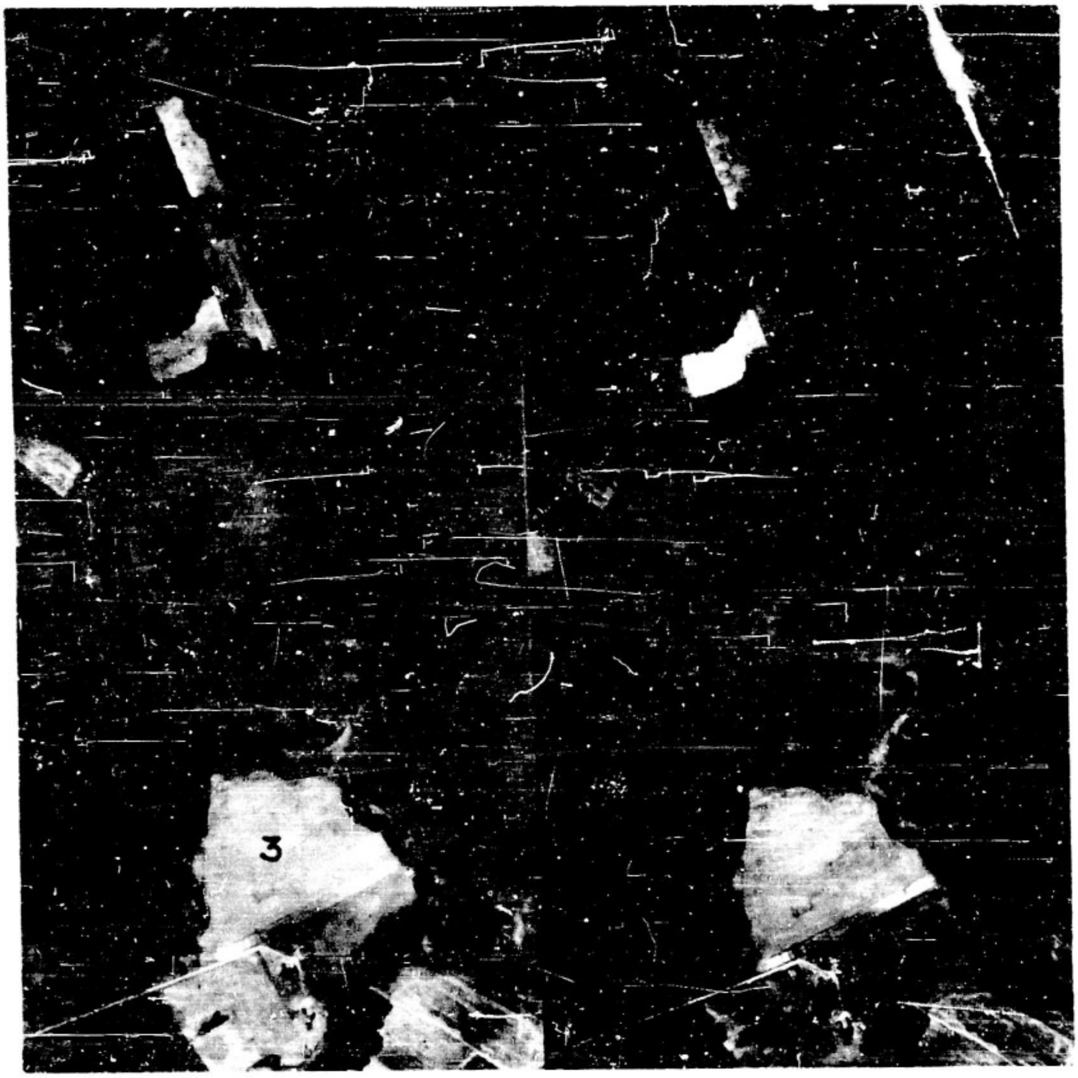
Fig. 8 - An ice scoured granite remnant 1.5 miles south of Deer Lock, Ontario. Scattered Spruce is shown in the background.

Fig. 9 - Typical kame and kettle topography along a recessional moraine. The tree at the left is a Red Pine.



Scale 1:10,000

Fig. 10 - ITASCA AREA. Many of the lakes in the Boreal Fringe Area are filling somewhat rapidly. In most instances the shore line is quite evident as shown by the advance of vegetation. Often times this advance is made possible by partial draining of the land around the lake. In such cases drainage ditches (1) are present. Usually the ditches are dug through marshes, peat and muskeg, or swamp (Sw) lands. The material floating around the edge of the lake is forming, or has formed, a floating bog. Railroads (2) and highways and trails (3), although straight like the drainage ditches (1), will not tie in with the lake and usually are built up above the surrounding area.



Scale 1:10,000

Fig. 11 - ITASCA AREA. Shore lines of old filled lakes stand out in stereo pairs. In most cases the shore line is designated by a definite row of trees. The old lake bed will have in it clumps of vegetation. Whether or not the lake bed has been put to use depends upon its present moisture conditions. The old lake bed shown in the above stereo pair is still in a boggy condition, as indicated by the attempted drainage through construction of drainage ditches (1). Roads (2) will usually appear in a lighter tone than the drainage ditches even though both are straight lines. A field in cultivation (3) will vary a great deal in tone depending upon the length of time since it has been used and the type of soil on which it is located. An abandoned field (4) will usually have a darker tone than one in cultivation due to the presence of vegetation developing in the abandoned field. Meadow lands (5) will often have a tone and texture of about the same degree as the old lake beds.

Chapter III

THE BIOLOGICAL ENVIRONMENT

In the areas of swamp and marsh land along the southern edge of the Boreal Forest, vegetation serves as the most important clue for the photo interpreter. On a large majority of the photographs the various types of vegetation form most of the images. The vegetation in any area is definitely related to the climate and land forms and to some extent the soils of that particular region (Fig. 12). In turn the species of vegetation is limited by the same factors. The recognition of vegetation associations and the ecological conditions for which they stand will help photo interpreters to determine the character of the area viewed which is not visible on the photograph.

Plant Associations

In the transition zone that forms the boundary between the Boreal Forests and its adjacent neighbors, the original vegetation cover is made up of three large groups: prairies, coniferous forests and areas of hardwoods. Except for small areas along the banks of permanent streams the prairies are treeless. There are very few, if any, conifers in the hardwoods area except within the transition zone. However, within the coniferous forests proper there are several species of hardwoods.

In composition, the coniferous forests from the New England states to Minnesota are essentially the same with perhaps the New England forests containing fewer Norway and jack pines than did the original forests of Minnesota and Wisconsin. The principal species in the areas

upon which this study is based are black, green, red, and mountain (very minor) ashes, big tooth and quaking (popple) aspen, balsam poplar, yellow and paper birches, basswood, wild black cherry, American elm, northern bur and northern red oaks, sugar and red maples, black and white spruces, balsam fir, tamarack, white, Norway and jack pines, and various shrubs such as willows, choke and pin cherry, hazel, and alder—the latter two being most prevalent.

The most fertile forest soils are usually occupied by the hardwoods. Basswood and maple are very tolerant of the shade of other species. When given a suitable soil, proper moisture conditions, and sufficient length of time they will crowd out most competitors. The spruces dominate in the more northerly sections, white spruces on the highlands and black spruce in the swamps. Tamarack and white cedar also occur in the swamps in addition to the black spruce. These species commonly grow in pure stands but are sometimes found in mixtures. Balsam-fir is more frequently found beyond the margin of the swamps.

The poorly drained areas that are covered with trees are properly called swamps. Similar areas which support no trees but are dominated by grasses, sedges and reeds are referred to as marshes. When sphagnum or peat mosses accumulate in the swamps or marshes they are referred to as muskegs. Large areas of open muskegs are found throughout the southern edge of the Boreal Forest. In such areas tree growth is usually choked out or stunted by the sponge-like moss and the excessive amount of moisture which it holds.

In burned over areas, aspen, jack pine, and birch will probably

Table 4 - Principal Trees and Shrubs in Areas Studied

Common Name	Scientific Name
Ash, black	Fraxinus nigra
Ash, green	Fraxinus pennsylvanica
Ash, mountain	Sorbus americana
Ash, red	Fraxinus pennsylvanica
Aspen, big tooth (large tooth)	Populus grandidentata
Aspen, quaking (popple)	Populus tremuloides
Basswood	Tilia americana
Birch, yellow	Betula lutea
Birch, paper (canoe, white)	Betula papyrifera
*Box elder	Acer negundo
Cedar, white (arbor vitae)	Thuja occidentalis
***Cherry, choke	Prunus virginiana
***Cherry, pin	Prunus pennsylvanica
Cherry, wild black	Prunus serotina
Elm, American (white, gray, water)	Ulmus americana
*Elm, slippery (red elm)	Ulmus fulva
Fir, balsam	Abies balsamea
Hophornbeam, eastern (ironwood)	Ostrya virginiana
Hornbeam, American (blue beech, water beech)	Carpinus caroliniana
**Juniper, prostrate	Juniperus communis
Maple, mountain	Acer spicatum
Maple, red (soft)	Acer rubrum
Maple, silver (soft)	Acer saccharinum
Maple, sugar (hard, sugar-bush)	Acer saccharum
Oak, northern bur	Quercus macrocarpa
Oak, northern red	Quercus borealis
Pine, jack	Pinus banksiana
Pine, Norway (red)	Pinus resinosa
Pine, white	Pinus strobus
Poplar, balsam	Populus tacamahaca
*Red cedar, eastern	Juniperus virginiana
Spruce, black	Picea mariana
Spruce, white	Picea glauca
Tamarack (eastern larch)	Larix laricina
**Willow, balsam	Salix pyrifolia
**Willow, bog	Salix pedicellaris
***Willow, pussy	Salix discolor
**Willow, sandbar	Salix longifolia
**Willow, slender	Salix petiolaris

*Box elder, slippery elm, eastern red cedar reach only into the southern edge of the coniferous belt.
**Are officially classified as shrubs, not trees.
***Are alternately classified as trees or shrubs - an "in between."

develop before other species. These trees serve as nurse crops for white and Norway pine and many other hardwoods. Much of the present northern forests is of the fire type complexion.

Lowland Forests

Spruce is the most common swamp tree found along the southern edge of the Boreal Forests in the area of this study (Table 5). This tree has an exceedingly wide natural range, extending from the Pacific to the Atlantic Ocean. It occurs in practically all of the forested parts of Canada and in Newfoundland. Only a small fraction of the natural range, however, lies within the United States.

Black spruce occurs most commonly in peat swamps. On such sites it is usually found in nearly pure stands although it may grow in mixture with a number of other species. Tamarack was once a common associate with black spruce in the Minnesota areas, but due to insect attacks is much less common now than previously. There are some sections which contain mixtures of northern white cedar and black spruce, although these two species tend to segregate into different types of swamps. Some paper birch and balsam fir will be found in most black spruce areas.

In the four type areas used for this report the black spruce, with its associated species, can be found in many stages of development. They range from the relatively primitive stages which have formed on excessively wet and poorly decomposed peat, where the black spruce is barely able to survive, to the more mature and drier ones, where the surface peat growing conditions appear to be similar to the growing conditions on moist mineral soil. The natural development of the peat has

Table 5 - Lowland Types of Vegetation

Name	Areas in Which Found			
	Ely	Hubbard	Koochiching	Itasca
Black Spruce	X	X	X	X
Cedar				X
Christmas Tree Bog			X	
Floating Bog	X	X	X	X
Lowland Brush	X	X	X	X
Marsh		X	X	X
Mixed Lowland Hardwoods	X	X		X
Muskeg			X	X
Stagnant Spruce	X		X	X
Stagnant Tamarack			X	X
Tamarack	X	X	X	X
White Spruce	X			

also been disturbed extensively and repeatedly by both natural and man made factors which include forest fires and the raising and lowering of water tables. With the exception of tamarack, no other tree in the areas studied can endure such a wide range of growing conditions as that regularly exhibited by black spruce in different swamps or different parts of the same swamp.

The usual pattern of productivity in most swamp areas is for the best growth to be at the border with progressively poorer growth toward the center. A transition zone, which can be classed as neither true swamp nor true upland, usually exists between two different areas unless the areas adjoining the swamp have an abrupt rise. In the Ely Area the swamp border types sometimes contain as much as thirty or forty acres (Fig. 14). In such cases the border areas are commonly underlain with boulders. Usually the best tree growth occurs in this band of swamp border. The decline in growth rate toward the center of the swamp may be slow or fast. In the areas of kettles, or small pocket swamps, the border zone may be down to twenty feet or less. However the transition in site quality is ordinarily much more gradual. Changes in the productivity of site from place to place within a swamp usually can be associated with some physiographic condition such as peat or drainage.

Tamarack swamps are common in the Koochiching Area and can be found in each of the other three areas (Fig. 15). Tamarack grows either pure or in mixtures with black spruce. In some instances cedar, spruce, and fir are mixed with the tamarack in the swamps. This tree develops in poorly drained acid bogs and swamps.

White cedar swamps, or the remains of what was once white cedar, are found in all four of the areas. Cedar occurs in pure stands or in mixtures with balsam fir, tamarack, spruce, paper birch, and balsam poplar. The white cedar swamps are best developed where there is a fair amount of drainage. This tree cannot compete with either black spruce or tamarack in the wettest of the swamp areas.

In the Itasca, Hubbard, and Ely Areas, mixed swamp forests are more common than those having pure stands (Figs. 16, 17). Swamps of this type are formed by mixtures of black spruce, tamarack, and white cedar plus white pines that may occur on the better drained uplands (Fig. 18). Mixed swamps then are made up of species that occur on both the uplands and in the swamps. Thus they may be considered as a transition type between the typical swamp forest and the upland forest. The distinction between cedar swamp, tamarack swamp and spruce swamp is based on the dominance of one of the three species. In general this dominance is determined by drainage conditions and somewhat by the depth and character of the peat on which it is growing.

> Tamarack swamps are usually found on the least drained lowland in which the peat is three or more feet in depth. Where the peat is between two and three feet deep and is better drained there is a greater mixture of spruce and cedar. Where it is shallow, from one to two feet, and the drainage is good, the swamp assumes the mixed composition of the transition type. Occasionally, the peat is ten to twenty feet thick and yet the swamp is fairly well drained; under such conditions all swamp species grow well. Apparently it is not the depth of the peat that affects the growth but the poor drainage conditions which are usually found in the heavier peat swamps. . . . . . Many spruce stands in the swamps have the appearance of young reproduction but upon further examination prove to be made up of old trees.*

*Zon, Raphael, Timber Growing and Logging Practice in the United States, (Washington, U. S. Department of Agriculture, Bull. 1496, 1928) p. 10

Upland Forests

In some respects the upland forests could be called the non-swamp forests. The principal upland species and associations are given in Table 6. There are, however, some upland sections in the Ely, Itasca and Hubbard Areas that contain enough moisture to produce some of the trees common to the lowland forests.

To some extent black spruce occurs in most upland forest types. However, it is relatively unimportant except in mixed forests of the spruce-fir type. In the Ely Area there are occasionally nearly pure stands of black spruce on rock outcrop formations, often in the presence of considerable numbers of jack pine. When black spruce is found growing in mixed forests it is usually smaller in size than its associates (Fig. 19). In the spruce-fir type of forest almost all native tree species are present to some extent. Balsam fir, aspen, white spruce, and paper birch are the most common however.

Aspen is the most common hardwood growing in the four areas used in this report. Most aspen grows on fine sandy loams, the heaviest soils in the forest. At the present time most of the aspen growing is less than fifty years of age. As these stands become older they will probably be invaded by conifers and the associations will gradually be changed to the upland conifer-hardwood type (Fig. 20).

The northern hardwood associations that occur principally on loamy moderate to well-drained upland soils are usually composed of basswood, sugar maple, yellow and paper birch, often with scattered white spruce and balsam fir. Those occurring on the stream bottoms, swamp borders and poorly drained uplands are usually of the ash-elm type of forest.

Table 6 - Upland Types of Vegetation

Name	Areas in Which Found			
	Ely	Hubbard	Koochiching	Itasca
Aspen	X		X	
Aspen-Jack Pine	X	X		X
Aspen-Paper Birch	X	X		X
Aspen-Spruce	X			
Cedar				X
Grass			X	
Hardwoods, mixed	X	X	X	X
Jack Pine	X	X		
Norway Pine	X	X		X
Oak	X	X		
Spruce-Balsam Fir	X			X
Upland Black Spruce	X			
Upland Brush	X	X	X	X
White Pine	X			X
White Spruce-Balsam Fir	X		X	X

Species included in this group are the American elm, black and green ash and red maple.

Collectively speaking for the coniferous forest zone of Minnesota, pines were, and still are, the dominant conifer on the uplands. Species composition of the pine stands has, as a result of cutting and fires, changed from a preponderance of Norway and white pine to one predominantly jack pine. The jack pine is usually in pure stands, but is sometimes intermingled in combination with one or more of the following conifers: (1) major associates—Norway pine and/or white pine, (2) minor associates--white spruce, balsam fir and/or black spruce. The type and extent of the combination varies with the site, history, and area involved.

Young stands of jack pine are often extremely dense--to the point of excluding all other tree species, reproduction, and brush, except along the edges. As the stand matures, weaker trees die out and the overall density decreases. One of several things may happen: (1) fire or a properly conducted harvest may repeat the cycle, (2) given the proper site and a species variety having cones which open easily, it may perpetuate itself, (3) other conifers such as white pine, Norway pine, white spruce, black spruce, may seed in and take over the stand, or (4) brush (hazel primarily) and/or aspen and birch may invade the openings in old, decadent stands and preclude the possibilities of both natural and artificial regeneration. Common ground cover species under a normal, vigorous stand of jack pine are bracken fern, blueberry, large-leaved aster, honeysuckle and hazelnut.

Plant Successions

Where the original vegetation cover has been disturbed the areas are now in the process of succession from primary to climax vegetation. Botanists and foresters familiar with this area, and similar areas, conclude that the successions would probably proceed along the following lines.

General Schematic Diagram of Lake Succession in the Southern Edge of the Boreal Forest

HARD WATER (Basic) SOFT WATER (Acid)

submerged plants,
water lilies, pondweed, duckweed

↓

Pioneer Mat
(sedges, cattails,)
(water willow, rushes)

↓

Moss-Heath Stage*
(leatherleaf, bog rosemary,)
(willows, bog birch, sphagnum mosses)

↓

Invasion Stage
(tamarack)

no. white cedar (basic or neutral waters)	no. white cedar-black spruce (waters of intermediate acidity)	black spruce (acid waters)
↓ no. white cedar; ash-elm-red maple	ash-elm-red maple; spruce-fir	ash-elm-r. maple and/or spruce-fir; bl. spruce

*may or may not be present

For other possible plant successions in the Boreal Area, see Appendix 1. The above diagram was worked out by Merle P. Meyer, Instructor in Forestry, University of Minnesota, St. Paul, Minnesota.

Military Usage

For military purposes certain characteristics of forest areas are of greater value than others. The characteristics listed under the headings which follow are described as if that area were a pure stand, or a stand in which the specific species dominates. In many cases where there is a great mixture of species some adjustments to the characteristics listed will have to be made. In general, however, these will serve the photo interpreter as a key to land usage under certain types of vegetation cover.

Aspen (Thick Stand)

(1) Concealment - excellent spring and summer when leaves present
(2) Storage areas - good
(3) Bivouac areas - excellent when leaves present
(4) Construction material - fair in log and lumber form
(5) Durability - fair
(6) Roads - soils usually stable for road construction

Aspen (Thin Stand)

(1) Concealment - fair if leaves present
(2) Storage areas - fair
(3) Bivouac areas - fair
(4) Construction material - fair in log or lumber form
(5) Durability - fair
(6) Roads - soils usually stable for road construction

Brush

(1) Concealment - usually poor if brush is not tall, possibilities of concealment of men
(2) Storage areas - unsatisfactory
(3) Bivouac areas - unsatisfactory
(4) Construction material - none
(5) Roads - unsatisfactory

Hardwoods, Mixed

(1) Concealment - excellent spring and summer when leaves present
(2) Storage areas - excellent

(3) Bivouac areas - excellent
(4) Construction material - good
(5) Durability - good
(6) Roads - very stable

Pine and Jack Pine

(1) Concealment - good in dense stands, fair otherwise
(2) Storage areas - excellent
(3) Bivouac areas - excellent
(4) Construction material - red and white pine very good for lumber and poles. Jack pine suitable but not as good as the other two.
(5) Durability - fair to good
(6) Roads - stable

Spruce

(1) Concealment - would be good but at the same time would probably be wet
(2) Storage areas - very poor
(3) Bivouac areas - very poor
(4) Construction material - good
(5) Durability - fair
(6) Roads - very poor. Would probably have to haul in material for the construction.

Tamarack

(1) Concealment - fair but would be wet
(2) Storage areas - poor
(3) Bivouac areas - poor
(4) Construction material - excellent poles and post material
(5) Durability - good
(6) Roads - soils not stable for road construction

Fig. Multicolored

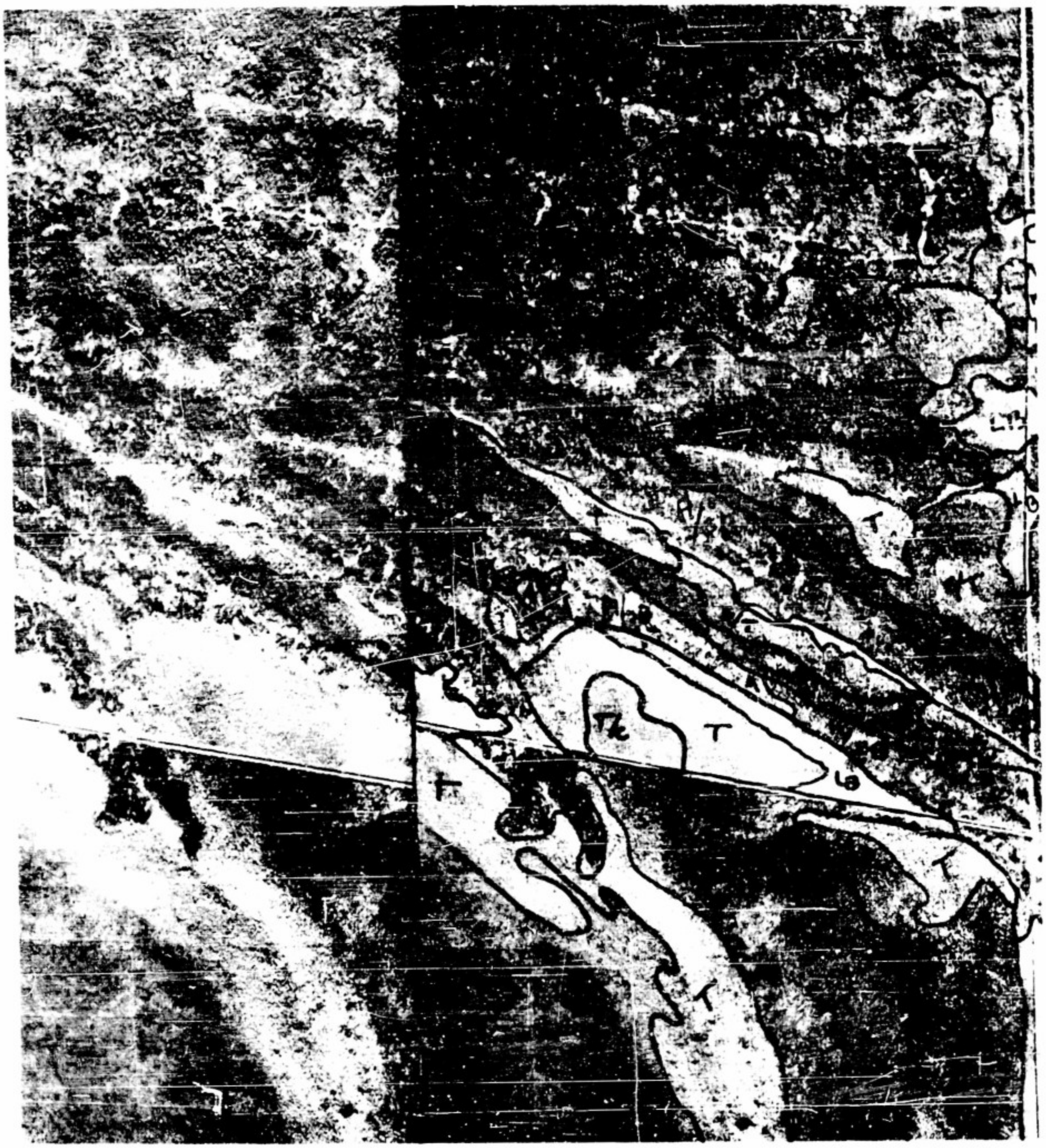
Fig. 12 - A nearly pure stand of Spruce bordering an esker in the Cloquet National Forest. The esker slope on the right is covered with Aspen, Birch and an understory of Balsam Fir. Eskers are composed of sand and gravel with a crude and discontinuous stratification and are excellent sources of road building materials. See page 88 for further comment.

Fig. MULTICOLORED

Fig. 13 - Spruce trees of various types have a wide range across North America, stretching in almost a continuous line from the Arctic shores of Alaska to the Atlantic coast line of Maine, Nova Scotia and Newfoundland. In many respects these trees mark the boundary of the wet zones. Spruce trees are very tolerant of moist and poorer soils, from sea level to elevations of about 5,000 feet. Generally the White Spruce when fully developed will be a tree from 40 to 70 feet tall with trunk diameters of 1 to 2 feet. It is often found in company with Aspen, Canoe Birch, Balsam and Black Spruce along the banks of streams and lake shores.

Scale 1:15,840

Fig. 14 - ELY AREA. This photo presents a good contrast between vegetation growing on the low wet lands as compared with that growing on the higher drier lands. Spruce (S), stagnant Spruce (Sx), Marsh (Mse), Tamarack (T) and lowland brush (LB) are all present in the wetter parts of the area. Aspen (A), Jack Pine (Pj), White Pine (Pw), Spruce and Balsam Fir mixtures (SB) and upland brush (UB) occupy the higher and better drained sections. Since this is an infra-red photo the tone and texture of the species shown should be compared with the tone and texture for the same species on Figures 15, 16 and 17 which are panchromatic.



Scale 1:20,000

Fig. 15 - KOOCHICHING AREA. The banded groups of vegetation in a large swampy area are somewhat typical. Spruce (S) and Tamarack (T) are in drier areas than the stagnant Tamarack (Tx) or the Christmas tree bogs (Sxs). Aspen (A), Spruce-Fir mixtures (SB) and hardwoods (H) occupy the driest areas. Good examples of Black Spruce cut-over (SCO) and Spruce-Fir cut over (SBCO) areas are shown.

Scale 1:10,000

Fig. 16 - ITASCA AREA. Examples of many kinds of vegetation can be found in a small area. Topographical differences in the areas occupied by upland brush (UB) and lowland brush (LB) can be easily distinguished. The more moist areas are easily identifiable since they are covered with stagnant Spruce (Sx). The drier areas have growths of hardwoods, dominantly Aspen (Ha), as a cover. Trails through moist areas are easily identified by the broken, tramped down, or killed out vegetation. The white dots in the farm (F) are stacks of hay that have been cut from the meadow.

Scale 1:20,000

Fig. 17 - HUBBARD AREA. In the moraine area, the principal vegetation is hardwood, primarily Aspen (Ha). Aspen, along with Jack Pine (Pj) occupy the drier and usually the more fertile areas. Upland brush (UB) is usually on the thinner soils. Lowland and wet areas are covered by marshes (Mse) and Spruce and stagnant Tamarack (S/Tx). Floating bogs (FB) are frequently found between the marshes and the lakes.

Fig. MULTICOLORED

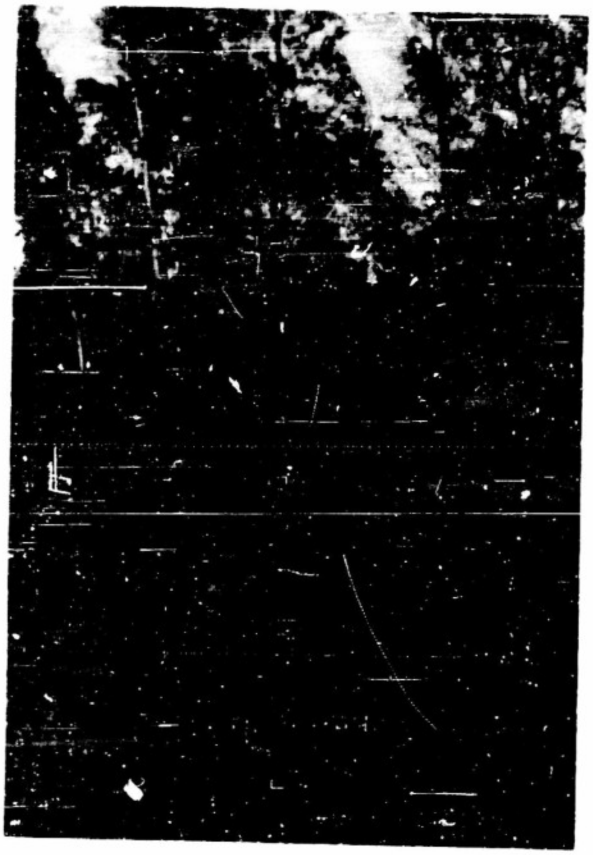


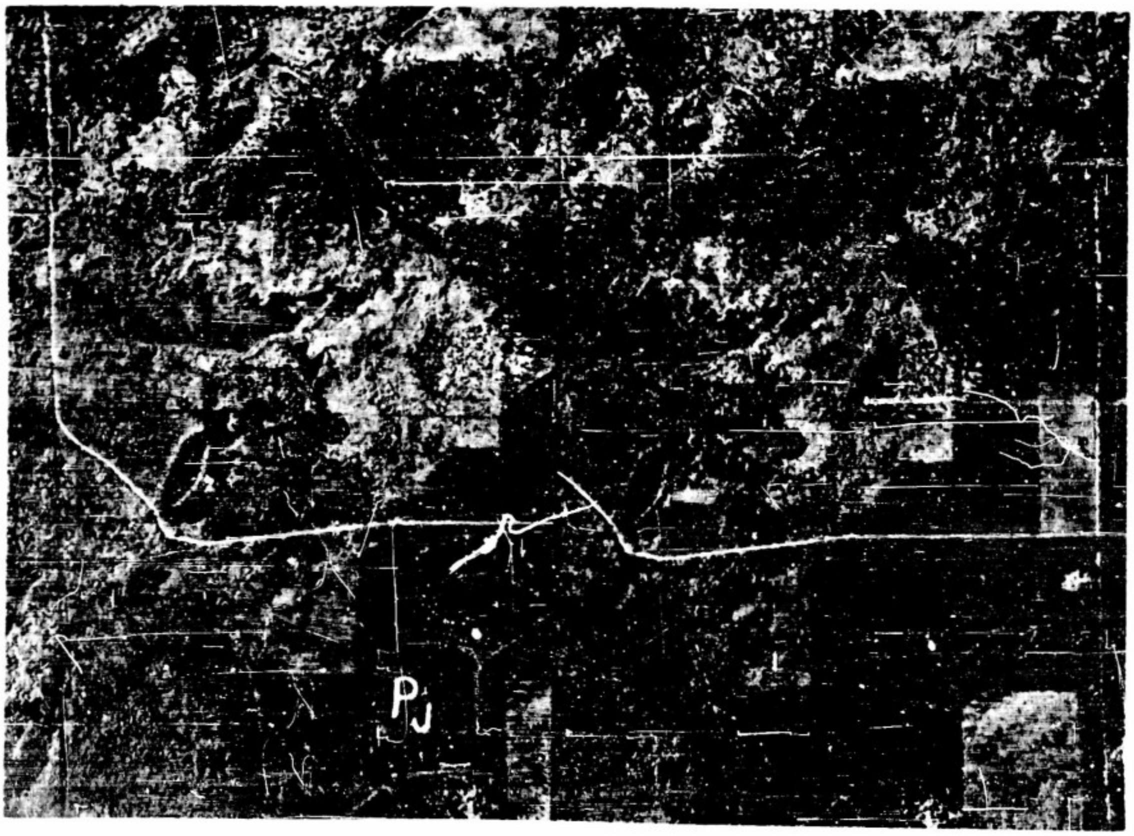
Fig. 18 - A mixture of White Cedar, Spruce and Aspen. The Northern White Cedar develops well in cool swamp areas or along the banks of streams or lakes from New England to southeastern Manitoba. Under very favorable conditions this tree attains heights of 50 to 70 feet with diameters of 2 to 3 feet. It is a slow growing tree. Aspen is also found along all parts of the southern edge of the Boreal Forest. It is the most common hardwood in the lake and swamp areas. Aspen frequently reaches 40 to 50 feet in height and 18 to 20 inches in diameter. It cannot withstand heavy shade. It is found mostly on sandy slopes and banks of streams in company with Pines and Spruce. In the Koochiching Area Aspen is frequently found growing along the banks of the drainage ditches where the peat and mineral matter dug from these ditches has been piled.

Scale 1:15,840

Fig. 19 - ITASCA AREA. Black Spruce (S) is one of the most common trees along the southern edge of the Boreal Forests. In aerial photos, either infra-red or panchromatic, the tone of the Black Spruce is usually darker than that of the other trees. Since it usually occupies more moist areas than the other trees it is a key indicator as to the land conditions under and around it. Hardwoods (H) have a much lighter tone than the Spruce. Pine (P) has a tone varying between these two. The above stereo pair illustrates very well the difference between the tones from these three trees, especially in infra-red photography.

Scale 1:10,000

Fig. 20 - ITASCA AREA. The land near rivers and streams is often covered with hardwoods (H) since it is drier than nearby level or higher areas. The more moist areas will have vegetation cover adjusted to such conditions. Tamaracks (T) are indicators of excessive soil moisture. Fields (2) may also reflect moisture conditions. The places having darker tones in this field (2) are wetter than the places having light tones. A highway (1) crosses the top of this area.



Scale 1:15,840

Fig. 21 - ITASCA AREA. On infra-red photos, such as this stereo pair, the coniferous trees always present a darker tone than the deciduous. Jack Pines (Pj) are common in many parts of the Boreal Forest Area. Usually the tree has a straight trunk. Its height ranges from thirty to seventy feet when fully grown. The diameter rarely exceeds two feet. The wood is light and soft although not strong. For military uses it will make suitable crossties, lumber and windbreaks.

Fig. Multicolored

Fig. 22 - Black Spruce, Pine and Muskeg. Black Spruce is a small tree that usually has a straight trunk and somewhat drooping branches. This tree, along with Tamarack, marks the limit of tree growth along the taiga-tundra boundary. It grows alike on bottom lands and mountain slopes. Along the southern edge of the Boreal Forest it is often confined to low bottomlands, sphagnum swamps and the margins of ponds where it is dwarfed. Often it is found growing to great age in floating bogs about the shores of small lakes. It is used extensively for Christmas trees. Pine growth is mixed with the Spruce. In the foreground is a muskeg.

Fig. MULTICOLORED

Fig. 23 - A virgin stand of Red Pine on the esker to the northwest of the fire tower in the Cloquet National Forest. The roadway follows the crest of the esker because available road materials, good drainage and gentle gradient favor road construction.

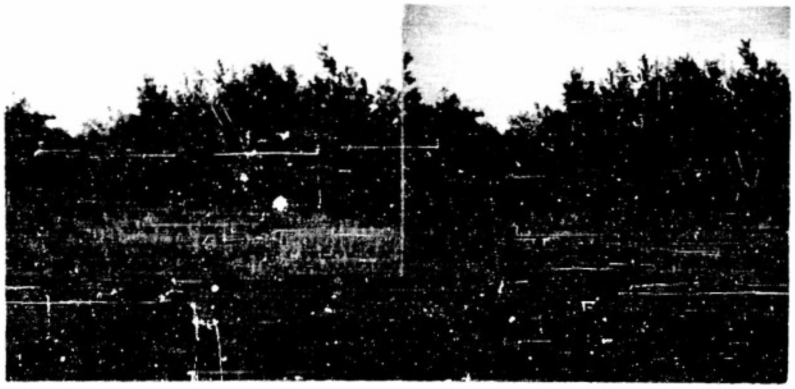


Fig. 24 - A marsh area overgrown with cattails, located approximately 3.4 miles north of Ericksburg. The dark, irregular band in the foreground is a drainage ditch.

Fig. 25 - Growth of fern in the Cloquet National Forest. Fern height, 2 to 4 feet, and density of growth varies with the amount of sunlight. The man in the picture is six feet tall.

Fig. 26 - White Cedars growing in a swampy locality along the Warba-Trout Lake road. This tree is a good indicator of moist areas.

Fig. 27 - An area of Tamarack growth in a swamp area one mile north of Waskish. Tamarack is distinctively a tree of swampy lands, venturing farther out on low lake shores and quaking sphagnum bogs than any other tree except Black Spruce.

Fig. 28 - Mixture of Aspen, Birch and Jack Pine in the Cloquet National Forest. These trees are indicators of dry areas.

Fig. 29 - Growth of Balsam Fir and Aspen approximately 4.8 miles east of Ray. Aspen is in the drier area along the road grade while the Balsam Fir occupies the more moist and shaded land back from the road.

Fig. 30 - Typical growth of Black Spruce in a swampy part of the Koochiching Area. The tallest of these Spruces is just over thirty feet. Stunted Black Spruce (Christmas tree bog) in foreground.

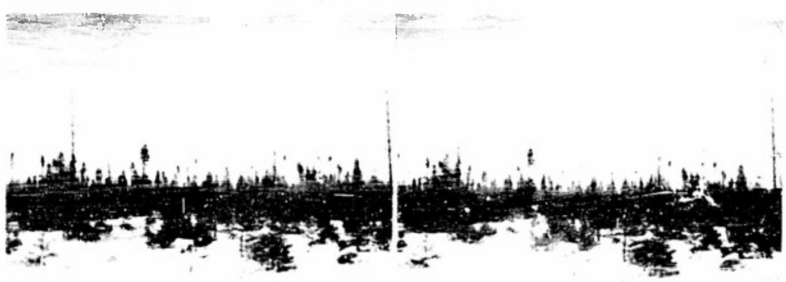
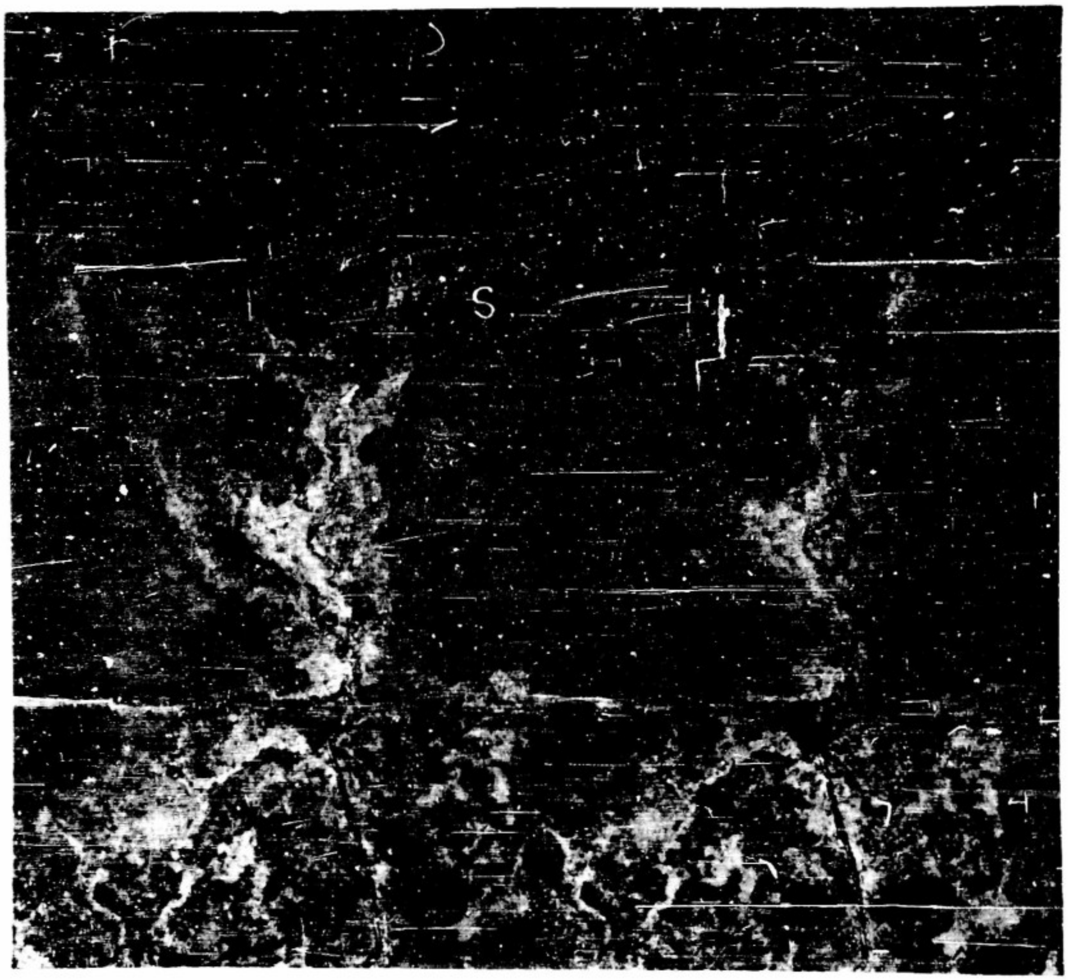


Fig. 31 - A growth of stagnant Spruce in one of the swamps of the Koochiching Area. Note the irregular heights of the trees and the growth at the top of the trees. Sometimes the trees were described by the local people as "turkey necks." Areas of stagnant Spruce present great difficulties to transportation.



Scale 1:20,000

Fig. 32 - KOOCHICHING AREA. This stereo pair is a good example of the differences in tone and texture between stagnant Spruce (Sx) and stagnant Tamarack (Tx). The contrast between Spruce (S) and stagnant Spruce (Sx) is also readily apparent. In this region all three types are indicators of wet and swampy lands, thus should be avoided if at all possible. Very little, if any, useable timber will be found in the stagnant areas. A drainage ditch (l) has been dug across the area. A small stream flows from the stagnant Tamarack (Tx) growth into the ditch. The black tone to the left of the stream is a small body of water. Along each side of the stream is a good growth of lowland brush (Lb). Across the ditch, on the side opposite the stream, clumps of trees have developed in the brush areas.

Chapter IV

SWAMPS AND BOGS

Swamps, bogs, marshes and all other such places are the result of both the physical and biological environments. Along the southern edge of the Boreal Forests such places are very numerous. They may vary in size from a small kettle of less than an acre to areas that extend over many hundreds of square miles. Swamps and marshes have always presented many problems to those who wish to use the land. They form definite blocks to transportation, some forms of communication and land utilization.

Peat is the remains of plants submerged in water. The plants from which peat is formed are, generally speaking, such plants as grow in water. The fact that the plants grow in water means that the plant foods which are contained in the water are used up by the growing plants. These food substances, or salts, include nitrates. Without nitrates vegetable or plant remains cannot decompose or rot. All decay of organic substances, animal or vegetable matter, is related to a process which is associated with nitrate substances. As water loving plants continue to grow year after year in the ponds or lakes, and in swamps or marshes, more and more the nitrate substances in the water are used up for food, and less and less remains, therefore, for the decay of the plants which grow and fall into the water. Thus an accumulation of vegetable matter gathers on the bottom of a pond or margin of a lake, and gradually develops into a peat bed.

A peat bog may be either a marsh or a swamp. If, however, the bog

contains the stumps and trunks of trees that have fallen into the bog and have submerged in the water, and imbedded in the remains of sedges, grasses, moss, and leaves, this would be called a swamp. The logs and stumps are not peat, but they are buried in a peat bed.

Peat consists of sedges, lilies, grasses, moss, and leaves, and the like, all more or less decomposed and packed together forming a "bed." Peat from Minnesota bogs may sometime be an important source of fuel as it is now in some parts of the world. A ton of wet solid peat contains 1,700 pounds of water and less than 300 pounds of vegetable or "fuel" matter.

Peat in bogs may represent all degrees of decomposition or rotting, from almost perfectly preserved vegetable tissue of leaves and grasses to black muck which is the same material almost fully rotted or decomposed. The muck is black because of the carbon or charcoal that remains. The carbonaceous matter of plants is the most nearly indestructible of any of the elements or substances of which plants are composed.

There are different kinds of peat bogs, according to the kinds of plants from which the bed has been formed. The kind of plants in turn that grow in any bog is determined by the conditions. In some bogs sedges abound; in others water lilies; still again sphagnum moss; in some bogs there are logs and stumps of trees buried, such a bog being a swamp; in others there are no logs or stumps, the bog being a marsh. The resulting peat bed may, therefore, be made up of any of these kinds of partly decayed plants, or of several of them mixed.

There are all degrees of decay in these bogs. In some the plant

tissue is nearly as sound as when it was growing. In other bogs the bed is so far decayed that it is a nearly structureless black muck.

Just as there are different kinds of peat beds, so the length of time required for the peat bed to accumulate varies. If the history of a peat bed, as shown by a study of its structure, revealed that it began in a fairly deep lake or pond, and plants having slender stems and leaves prevailed, it might have been many centuries forming. On the other hand, a peat bed that originated in a swamp where trees grew and contributed their stumps, roots and trunks, as well as twigs and leaves, might grow and accumulate more rapidly. There are peat beds in Minnesota that are 10, 20 and even 40 feet in thickness. Some of these show by their composition and structure that they accumulated very slowly.

When a peat bed chances to be cut through by a railroad grade, a road, or a drainage ditch, so that a section of the bed is shown, it is often found possible to determine the history of the bed. At the bottom, under the peat bed, may be evidence to show what the conditions were before the peat bed began to form. In other words, it may be shown what was there before the bog began. Where now is bog may have once been the shore of a lake, as shown by a deposit or layer of sand and shells. It may have been at one time a lake bottom, as shown by shells in a deposit of mud. It may have been a shallow bay or slough, as shown by pond lily seeds and roots, or by seeds, stems, or roots of other slough vegetation. It may have been a marsh or swamp, and later developed into a peat bog; or it may have been dry land in the first place, as shown by stumps and roots of jack pine or of hardwood trees such as grow only on well-drained

land. The peat bed itself may have begun from sedges, grasses, or moss, or any of the peat forming vegetable matter that has been referred to.

The successive layers of the peat bed may show the changes that have taken place in the history of the bog. It may have been at first a marsh. Conditions may have changed so that later trees grew and the bog became a swamp. Sedges, grasses, sphagnum moss, and other plants may also be found in successive layers, showing the history of the series of changes in the character of the bog.

In many places swamps and marshes are found with the marks of a lake around them. With the banks and beaches of a lake shore all around the edge of a swamp, and a peat deposit from one foot thick at the margin to ten feet or more at the center, no further evidence need be considered necessary to prove that a lake has been transferred into a peat bog and is slowly accumulating a peat bed. But there are also many such swamps with open marshes or with sloughs, or even clear lakes or ponds at their centers. In fact, every degree of bog growth can be seen in Minnesota from clear lakes or ponds to those overgrown by vegetation until they have become swamps and marshes, showing how some lakes have been and are being filled by growth of bogs around their outside borders, and gradually encroaching toward the center (Fig. 35). Thousands of what were once shallow lakes in Minnesota have become marshes and swamps in this way.

Peat moss, called sphagnum, thrives in moist places, and this moss acts as a sponge, holding water to keep itself and the place where it grows wet. In the dense shade of a forest, this moss will thrive where

it could not grow at all if the trees did not shade the ground. A growth of such moss a foot or more deep clogs drainage of the land and makes it swampy where there would be well-drained ground if the moss were not there. Groves of large spruce, of large tamarack, or of cedar, with some other varieties of trees scattered among these, and all standing surrounded by a foot or more of peat moss, make the beginning of a muskeg. As the peat deposit becomes deeper and deeper under the growing moss, the swamp becomes more and more wet. The trees that now survive are smaller. Gradually the larger trees are drowned out. This is the second stage of a muskeg. Such swamps are often on gently sloping land surfaces that would be dry except for the peat bog vegetation which holds the water from draining away.

With the wider spreading of the muskeg condition and with the deeper depositing of peat at the center, or where the muskeg began to form, an open marsh is formed. This is surrounded by a stunted growth of small spruce or tamarack. Outside of the zone of stunted spruce and tamarack, there is a zone of trees of larger growth.

In northern Minnesota marshes and swamps spread out one into another, uniting lake bog and forest bog over a wide area. For miles in extent covering whole townships, except for a few high places which stand as "islands" on the smooth muskeg landscape, what has been called the great Beltrami "swamp"--really the great Beltrami muskeg--spreads out from Red Lake and the Rainy River east to Vermilion Lake. On the Mississippi from Hill City to Palisade and McGregor at Island and Meadowlands in the St. Louis Basin, are other examples of muskeg.

Muskeg does not, of course, belong at all to the prairie region. The peat moss which has sometimes made shady forests over into peat swamp and peat marsh cannot grow at all on the sunburned and windswept prairies. Peat beds of any kind are not extensive in the prairie regions, and those which do occur there are from sedges and grasses in overgrown sloughs and lakes. In the forested region, both the overgrown lakes and the mossy forest type of muskeg have grown up. Those two types of bog are not only found side by side, but also in succession. The muskeg or mossy swamp has followed upon the overgrown lake frequently, and, again, the growth of muskeg has sometimes blocked the streams so that lakes or open marshes have resulted where had once been dry, forested lands. The great muskegs which are miles in extent in the North are just like the smooth prairie lands in every way as to subsoil and landscape features, except they are overgrown with peat moss with peat beds underlying the moss for the greater part from one to twenty and even forty feet thick.

From Mendota to Savage along the Minnesota Valley there is a sloping bog. There is also a notable one near Mounds Park in St. Paul. There is always spring water seeping or flowing out of the upper side of hill bogs, and a growth of sedges, grasses, or moss with willows and other vegetation choking the drainage of what would otherwise be streams flowing from the spring. The bog becomes a peat or a muck deposit.

Hill bogs usually build up a terrace on the hillside from which the springs break out. Occasionally such a bog is built up on a flat plain

or meadow. In this case a low, broad mound is built up with a spring issuing at the top (Fig. 34). In attempting to walk toward the top of such a mound, one gets into worse bog when he may be endeavoring to get out of it.

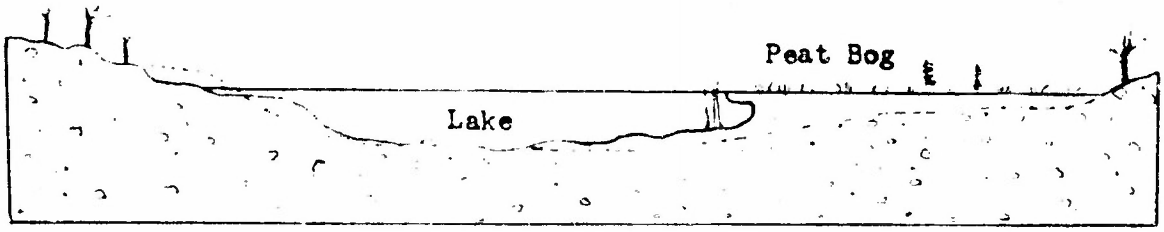


Fig. 33 Cross section of a lake showing wave-cut shore (left) and bog filling (right).

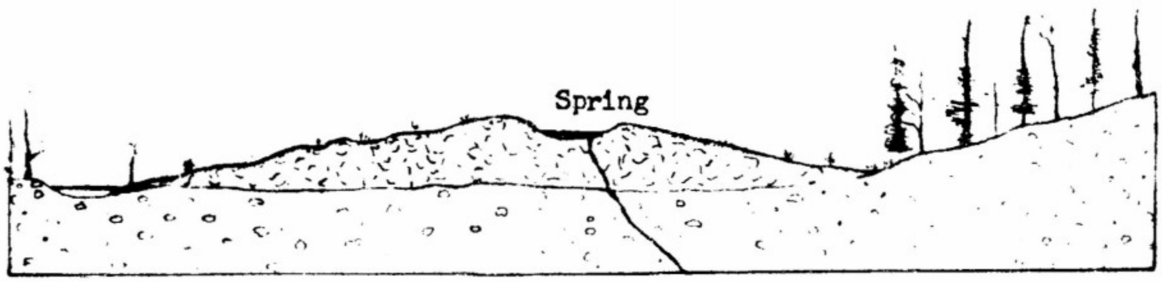


Fig. 34 Raised bog. The contact between the glacial drift and organic accumulation is the original land surface. The bog has grown up around the spring.

Fig. MULTICOLORED

Fig. 35 - This color picture is a "Kodachrome" while the previous color pictures have been "Kodacolor." The coloring in this photo is a little too green to represent an exact picture. It is, however, more accurate than the coloring in the previous photos. The cost of the "Kodachrome" is about four times greater than the cost of the "Kodacolor." Both will fade when left in direct sunlight, however, "Kodachrome" will hold its color the longest.

The above photo was taken in a swamp and bog part of the Koochiching Area. Black Spruce is the dominant tree in the background. Much of the area in the foreground is a marshy floating bog. The material around the lake will tremble as one walks across it and one may break through without notice. On each step a 200-pound man will sink in to his knees if wearing regular shoes whether on the bog or along the edge of the forest. In the forest itself deep footprints, that fill quickly with water, will be the rule.

Fig. Multicolored

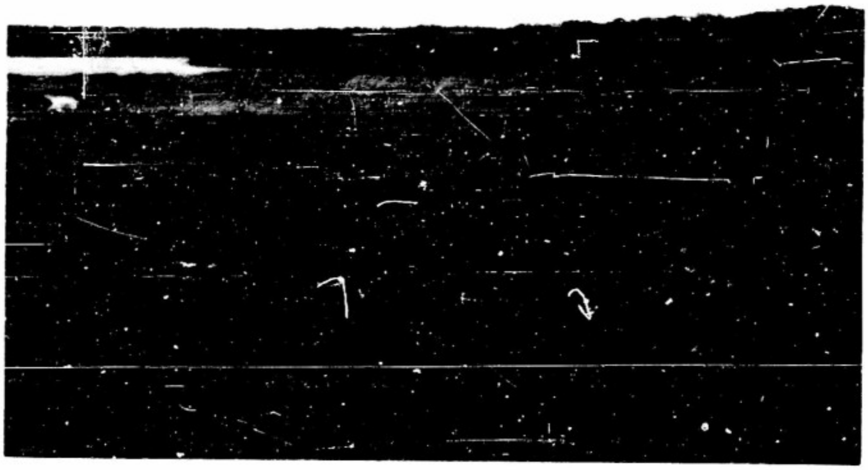


Fig. 36 - A filled arm of Pughole Lake in the Itasca Area. This area is typical of the evolution of many shallow lakes in the morainic portions of Minnesota. The peat and sphagnum moss are of sufficient age and elevation to support a widely scattered stand of stunted Spruce. Cyclic fluctuations of high lake levels have seriously interfered with the growth of trees on these filled basins.

Fig. MULTICOLORED

Fig. 37 - The contact line between the reed filled portion of the lake margin and the peat bog is in the right foreground. Black Spruce in the background is on higher land slightly above the water table. Dead trees in the middle distance are probably the victims of a period of abnormally high water.

Fig. 38 - A bog and marsh area approximately one mile southeast of Ericksburg. Aspen trees in the background indicate drier land.

Fig. 39 - An Alder swamp 3.5 miles north of Cook on U. S. Highway No. 53. The dense growth of Black Spruce in the background indicates the location of a large swamp.

Fig. 40 - A Tussock marsh in the Cloquet National Forest.

Fig. 41 - A filled in lake in the moraine section of the Hubbard Area. At first glance the area appears to be a hay field or pasture. From the air it appears to be a level meadow or pasture. Areas such as this are very difficult to pick out on aerial photos because of their size.

Fig. 42 - Aspen, Black Spruce and Red Pine growing on a relatively dry lake shore in the Cloquet National Forest.

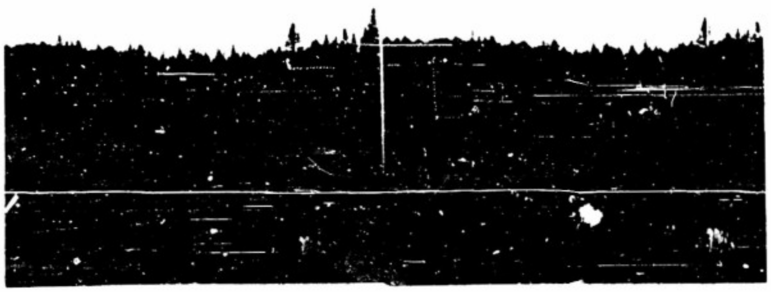
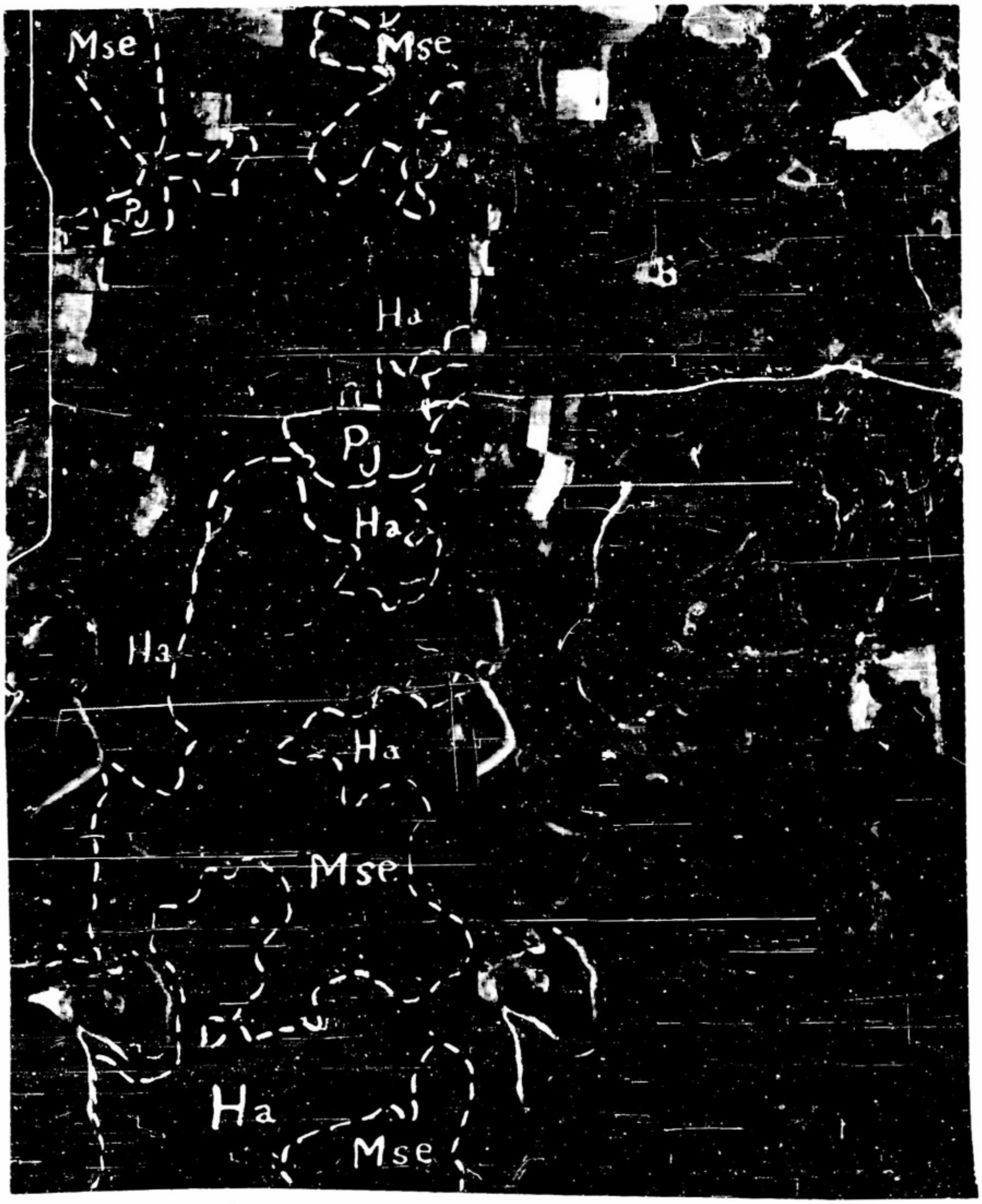
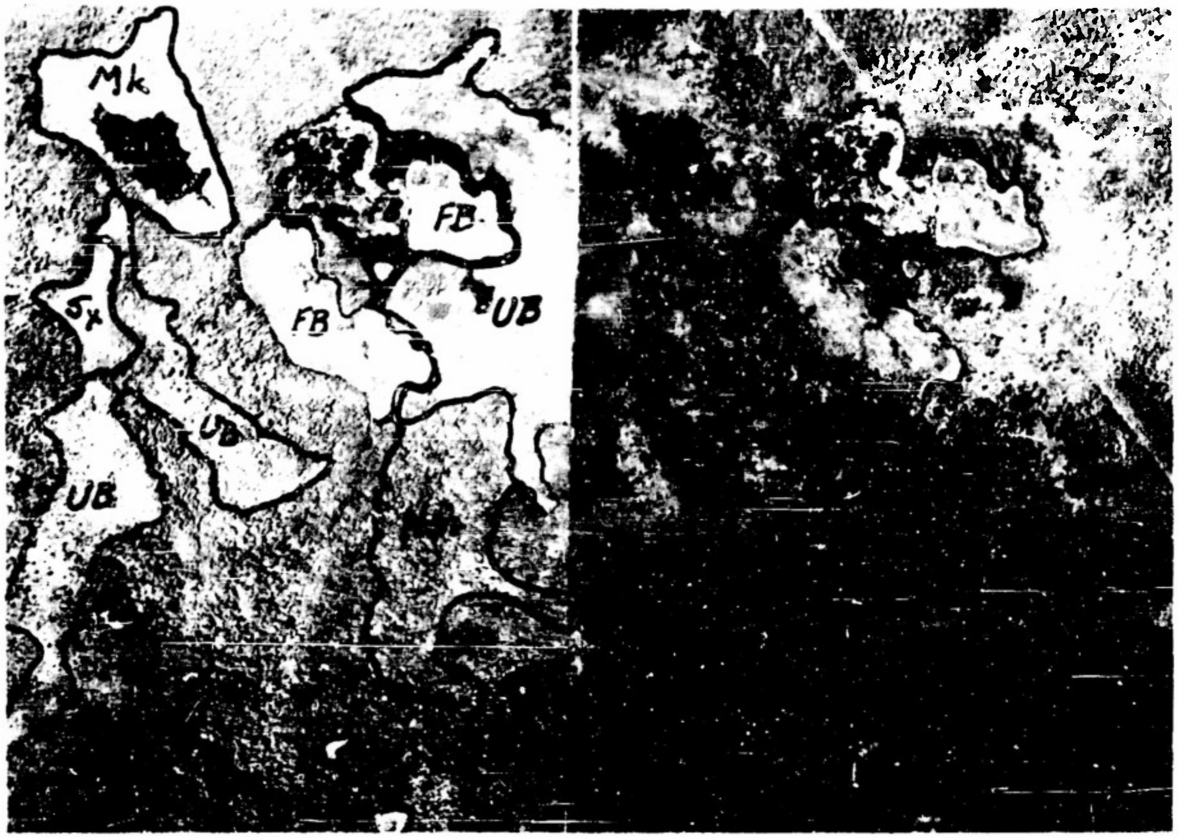


Fig. 43 - The small trees in the foreground form part of a Christmas tree bog. Excess water killed the larger Spruce. A Black Spruce swamp covers the background.



Scale 1:20,000

Fig. 44 - HUBBARD AREA. Marshes (Mse) of various sizes are to be found scattered throughout this area. They are generally surrounded by higher, and usually drier, ground on which hardwoods, mostly Aspen (Ha) and Jack Pine (Pj) are growing. Frequently the marshes will form in the arm of a lake that is filling. In such cases the part of the marsh nearest open water may be a floating bog. Useable farm lands (1) will be in the higher areas. Roads (2) will avoid the marshes whenever possible.



Scale 1:10,000

Fig. 45 - ITASCA AREA. Muskegs (Mk) and floating bogs (FB) as well as marshes (Mse) occupy depressions or low places. The muskegs are usually soft, velvety, mottled and medium to light gray. They sometimes have a dappled appearance with soft light gray spots on dark blotches. Floating bogs appear mottled and somewhat bumpy. Generally the bogs will have isolated arms or small ponds of water visible. These areas, which should be avoided, are often surrounded by higher land covered by mixed hardwoods (Hm) or Aspen (A). Upland brush (UB) will also cover some of the higher ground. Clearings made through the hardwood areas are easily identifiable because of the path like clearance.

Scale 1:7,500

Fig. 46 - ELY AREA. During the winter season swamps (Sw) of all kinds are frozen to a depth great enough to support the heaviest logging equipment. Often trails (1) in the swamps are preferred since they are more level and easier to travel over than trails over the higher, rougher surrounding land. In many cases the swamps are separated from lakes by narrow highlands.

Scale 1:15,840

Fig. 47 - ELY AREA. In the areas of glaciated crystalline rocks Spruce (S) grows on the dry hillsides and hilltops in conjunction with various hardwood (Ha) species. Spruce (S) will also be found growing in the valleys and along the edges of swamps. In this stereo pair, just above the Ha, is what remains of a lake being filled in. The black in the center is open water. Along its edges are marshes and floating bogs. Some Spruce trees can be noted along the outer edges of original lake. Road building (1) in such an area is usually concerned more with the rock structure than with swamps. Lumbering in the past is shown by the cut-over Spruce (2).

Fig. 48 - Walking along the edge of a swamp is difficult. The grass in the photo is less than two inches in height. The going gets tougher with each step toward the heart of the swamp.

Fig. 49 - Close-up view showing the difficulties of walking over ground that appears solid.

Fig. 50 - A drainage ditch that has been dug through a portion of the "Pine Island" section of the Koochiching Area. Even though the ditch is full of water little drainage takes place. In the foreground is marsh, in the background a Spruce swamp.

Fig. 51 - A Spruce growth in which the large trees have been killed by water. Closely resembles a burned area. Much of this area is classed as a Christmas tree bog.

Chapter V

TRANSPORTATION AND COMMUNICATION

In all swamp, bog and forest areas, the problem of transportation is always a critical one. Along the southern edge of the Boreal Forest, especially in that part where swamps, moraines and rock outcrops are intermixed, can be found some of the most trying if not the most difficult problems in highway engineering. In many cases it is not the lack of suitable road building materials that presents the problem, but rather the construction of a suitable road bed on which the engineer can put the road building materials available.

Bogs and swamps will vary in depth up to thirty and forty feet. Sometimes the actual floor of the bog or swamp is of such unstable material that it must be considered a part of the swamp itself, thus presenting another problem of movement of non-useable materials. In the peat swamps, especially the large ones such as are found in the Koochiching Area, the building of a road across and over unstable materials will extend for twenty-five or thirty miles or longer. Under such conditions the construction of a satisfactory road takes a very long period of time. Even the building of bridges over smaller swamps requires a great length of time. In general, highway construction avoids the swamp areas if at all possible. When roads are constructed they curve around the swamp or follow the edge of it and cross the swamp directly only when it cannot be avoided.

Transportation

The best time for the construction of highways is from May to October,

or during the summer season. In the winter, freezing makes road construction too expensive to grade and pave. In the laying out of the roads, moraines and high ground areas are followed wherever possible. If it is necessary to go through swamp lands two methods are followed. If the swamp is shallow it is dredged out and then filled in. If the swamp is deep the road is "floated" across. An example of this latter type of road is the one from Waskish to Baudette. When this last type of road is put down it will carry heavy machines, provided they are not too close together and that not too many of them use it in a short period of time.

Road building can be carried on in the hill and valley or rolling country within one-half hour after a heavy shower. In the flatter areas a much longer time is necessary before heavy equipment can be utilized. If the roads are built on higher grounds they remain open longer during the winter season. Also there is a better chance for the snow to blow off when the roads are on higher ground.*

The Highway Departments of Minnesota, Wisconsin and other states in this area have set up very specific regulations for the construction of roads. The following is from a letter of September 9, 1953, written to the Project Director by Mr. J. C. Robbers:**

> It has been and still is our practice in connection with the surveys and preparation of plans to make hammer soundings to determine the bearing power of the soil and to make borings to determine the kind or kinds of soils. This information is transferred to the cross section sheets and enables our designers to estimate how much of the peat must be removed and the amount of subsidence that can be expected.

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*Mr. H. A. Pabst, District Engineer, Department of Highways, State of Minnesota, Bemidji, Minnesota

**Mr. J. C. Robbers, Assistant Chief Engineer, Department of Highways, State of Minnesota, St. Paul, Minnesota

The peat excavation is performed under a specification which provides that the excavation be made to the cross section and elevation shown in the plans or as directed by the engineer. This swamp material is usually moved by draglines to the sides of the proposed new fill. As this material is being moved, the new material is being placed in the excavated area. The dragline operates from the surface of a constructed new fill. Across swamps with deep soundings the new fills are overloaded with sufficient material to obtain the designated subsidence. This overload is permitted to stand for several months and before completion of the grading and surfacing, further soundings are taken to insure complete submergence of the new fill or suitable compaction of the underlying remaining peat material. After completion of the fill section the excavated swamp material which has previously been cast to either side of the new fill is then disposed of by leveling off the slopes of the new fill.

In all cases where the material is available the submerged portions of embankments or swamps are made of sand or gravel, payment for which is made by roadway excavation or barrow excavation depending upon the source for available material.

The following is an excerpt from Specification 2110 about Embankment Construction which the Department of Highways, State of Minnesota, has used for many years and have found successful.

2110.3E Embankments in Swamps

Embankments in swamps or water shall be constructed in accordance with the following requirements:

Filling swamps will not be permitted when frost interferes with the settlement of the embankment.

When the sides of a trench excavated through a swamp do not "stand up," the operations of placing the embankment shall follow immediately behind the excavation.

Layer construction and mechanical compaction will not be required for the submerged portions of the embankments, but will be required for the portions above swamp or water level, except that, when subsidence is to be forced by overloading or blasting, layer construction and mechanical compaction will be required only for those portions of the embankment which are constructed after subsidence satisfactory to the Engineer has been secured.

The submerged portions of the embankments shall, so far as practicable, be constructed by placing a central core to an elevation above

swamp or water level and then advancing and widening that core. If, at any time prior to or during the construction, the Engineer determines that it is necessary to resort to overloading or blasting in order to obtain satisfactory subsidence, the following procedure shall be followed. The Contractor shall breast out the embankment to the width and height designated by the Engineer with side slopes as steep as practicable. After the embankment has been placed as above provided, explosive shall be placed under it to force subsidence by blasting (by the Contractor's forces or by others) if and as directed by the Engineer. After such blasting, or after the overloading has caused subsidence, the Contractor shall smooth off the top of the embankment to facilitate borings to determine the amount of additional embankment which may be required. The procedure of overloading, or overloading and blasting, shall be repeated until the Engineer considers that satisfactory subsidence has been secured, after which, at a time designated by the Engineer, the Contractor shall complete the embankment to the established grade and cross-section by adding more material or by removing any excess.

In all glaciated areas, eskers, kames, kame terraces and outwash plains can serve as good foundations for the building of highways.* Professors Harold E. Young and Lawrence A. Wing** of the University of Maine, have noted the following characteristics about each of the glacial forms named above.

<u>Eskers</u> are long narrow ridges of gravel and sand. Eskers are generally confined to valleys and even here to the lower ground. They frequently wind from one side of the valley to the other and are often cut by present day streams with portions completely washed away. Eskers are composed of sand and gravel with a crude and discontinuous stratification and are excellent sources of road building material. As eskers are freely drained, free from excessive frost heave, and always free from ledge excavation, they make ideal locations for roadbeds. Stereoscopic study of air photos will disclose most eskers regardless of vegetation, and in some instances they can be located without recourse to a stereoscope.

*For the photoidentification of these features see William E. Powers, <u>A Key for the Photo Identification of Glacial Landforms and Associated Landform Patterns in the Lake Michigan Region and Comparable Areas</u>, Technical Report No. 2, Geography Department, Northwestern University, Evanston, Illinois, ONR Project No. 089-005.

**Harold E. Young and Lawrence A. Wing, <u>Use of Air Photos for Location of Truck Roads and Road Building Materials in Maine</u>, Technical Notes No 20, Forestry Department, University of Maine, Orono, Maine.

__Kames__ are hills or small mounds of gravel and sand of about the same composition as an esker. As a rule they tend to be conical in shape although irregular shapes are not rare. Kames may be as much as 2000 feet in diameter or as little as 100 feet with a height ranging from a few feet to about sixty feet. They usually occur in valleys, often with or near eskers, and may be found as single isolated kames or in groups called kame fields. Kames are made up of poorly sorted and poorly stratified gravels and sands and are considered fairly good sources of construction material if the deposit is large enough. A dense stand of softwoods may completely mask a kame even when examined stereoscopically. However some of the larger kames can be located stereoscopically regardless of the vegetation and moderate sized kames can be located on land that has been burned and is covered with a young stand of birch and aspen.

__Kame Terraces__ are deposits of stratified sand and gravel forming irregular and discontinuous terraces along the sides of a valley. The terrace tops may be relatively flat or may be pitted and hummock. A kame terrace is made up of gravel and sand showing a wide range in degree of sorting and stratification, and is an excellent source of construction material as well as an ideal roadbed. As roadbeds they drain freely, are frost free, and are generally free from ledge excavation. On air photos kame terraces covered by forest stands cannot be identified stereoscopically, however stream valleys can be easily located and kame terraces, if present, are usually within a few hundred yards of the center of the valley.

__Outwash Plains__ are composed mostly of fine gravels and sand with a rather uniform horizontal stratification. As they are deposited by sand laden waters flowing from the melting ice the coarser particles are likely to be found near the source. These plains are characterized by their very flat nature with occasional pits or "kettle holes" on the surface. The flat nature of the deposits makes certain identification from the air photos virtually impossible. Outwash plains offer the largest and best sorted sources of construction material as well as excellent roadbases. All flat areas that do not show ledge outcrops or boulders on the surface should be tested as possible outwash plains.

Although the statements made by Young and Wing were for the state of Maine, they will apply to any similar area such as that covered by this series of reports.

During the winter season the bogs and lakes do not present the difficulties to transportation they do during the summer season. In most parts

of the areas being studied ice begins to form soon after the first of November. Naturally the exact time that ice forms depends upon the weather conditions for that particular year. Under average conditions the ice is thick enough to carry any kind of vehicle by the last part of December. Ice travel usually ends about the first of March. Prior to the middle of December and after the first of March ice travel is extremely hazardous. The use of the ice during the winter season can be hastened by removing the snow as soon as possible after it falls, thus the cold winds and lower temperatures can freeze the water quicker and to greater depths. One inch of blue ice (clear ice) will support a man, six inches of blue ice will support large trucks loaded with logs. It is not unusual for the ice in this area to attain a thickness of twenty-four to thirty-six inches during the winter season. Where the ice on the lakes is smooth enough airplanes on skis use the lakes for landing fields.

Travel on foot through swamp areas is much easier in the winter season than in the summer season. During both periods of time, however, snowshoes have been successfully used. In the Koochiching swamp area many of the hunters use wide skis for crossing them during the summer season. The most dangerous time to be walking in swamp areas is during the spring thaws. A part of the swamp may still be frozen while an adjacent part has thawed out. Thus it is possible to be walking on a firm foundation and with the next step be in muck or mud to your knees or shoulders.

Communication Lines

Should it be necessary to establish pole communication lines or

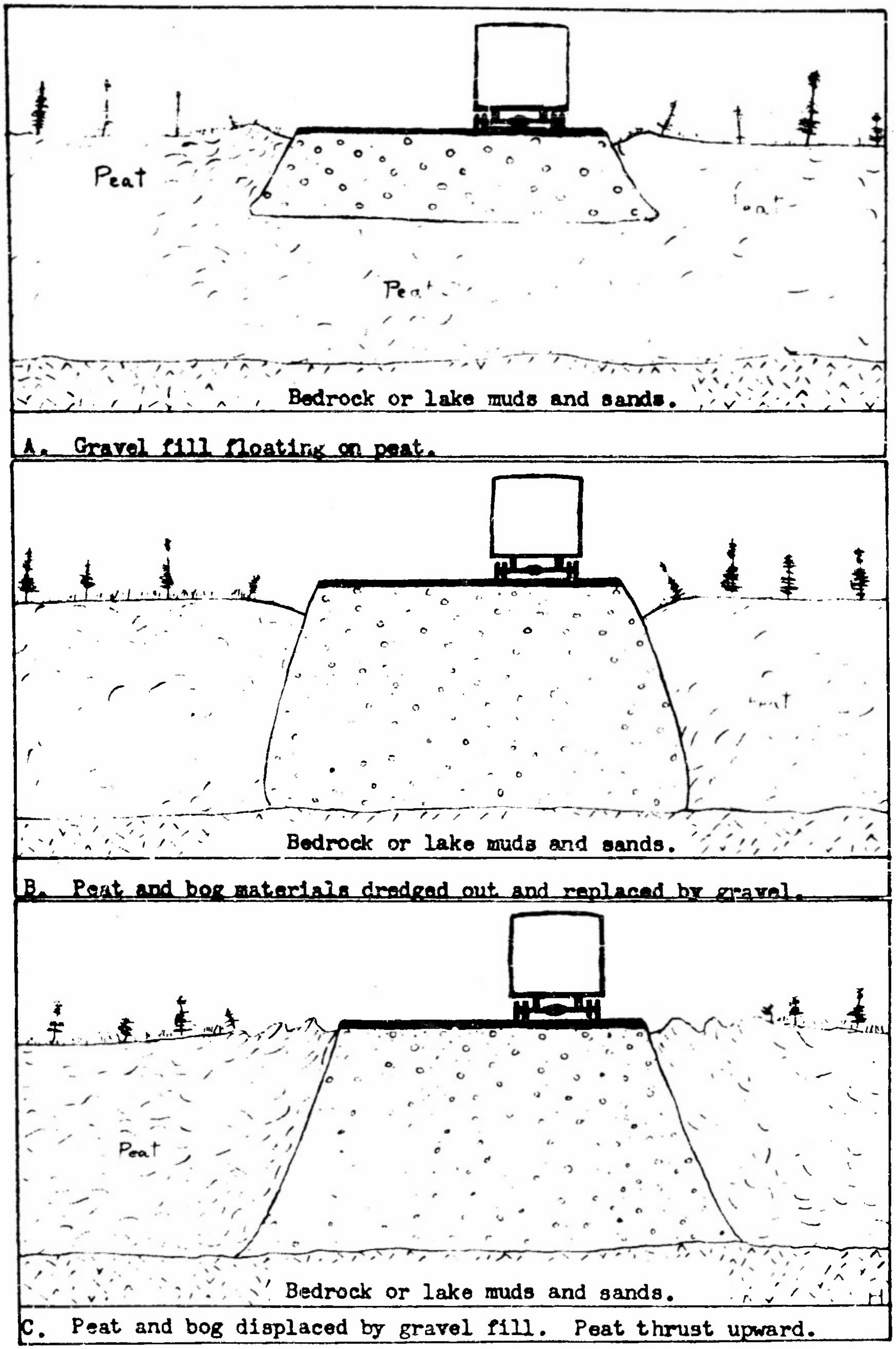
power lines through a swamp area a great deal of care must be taken in putting down the poles. In some areas they are set in a rock base while in other regions the poles are tied down by guy wires. Large power lines like that leading from the Winton Dam are set deep enough into the ground to be stable at all times. When crossing swamp areas occasionally an extra length of pole material is needed in order to attain a safe depth. The Rural Electrification Administration in Koochiching county has established the following three steps in clearing right-of-way for power lines:

(1) A bulldozer is used to push over trees and other vegetation.

(2) A second dozer follows behind to break the remaining trees and vegetation. This dozer pulls a crimper that further breaks following vegetation of smaller size.

(3) A crew of men with chain saws follow behind the dozers and cuts saleable lumber out of the litter. Stumps are cut as close to the ground as possible. Some controlled burning is done to further clear the right-of-way. The final cleared area is between twenty and twenty-five feet in width.

Figures 53 and 54 show the telephone pole procedure used in Northern Minnesota and adjacent areas of Canada.



A. Gravel fill floating on peat.

B. Peat and bog materials dredged out and replaced by gravel.

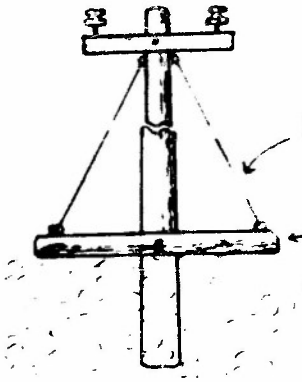
C. Peat and bog displaced by gravel fill. Peat thrust upward.

Fig. 52

Methods of Erecting Telephone or Power Poles in Swamp and Bog Areas

1. Bog Conditions - Koochiching County, Minnesota - Used by REA (Unknown depth bog)

Side view



Top view

Pole

Lateral wire rope braces

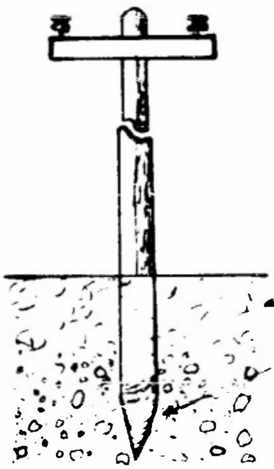
Cross beam (old pole - bolted to wire pole)

Peaty layer (depth varies)

Depth pole is set in ground varies with peat, etc.

2. Bog Conditions - Koochiching County, Minnesota - Used by REA (Known depth bog)

Side view



Anchor Method.

A combination of 2 and 3 can be used under some conditions.

In No. 2, lateral support is gained from the wire rope and longitudinal support is gained from the transmission wires themselves.

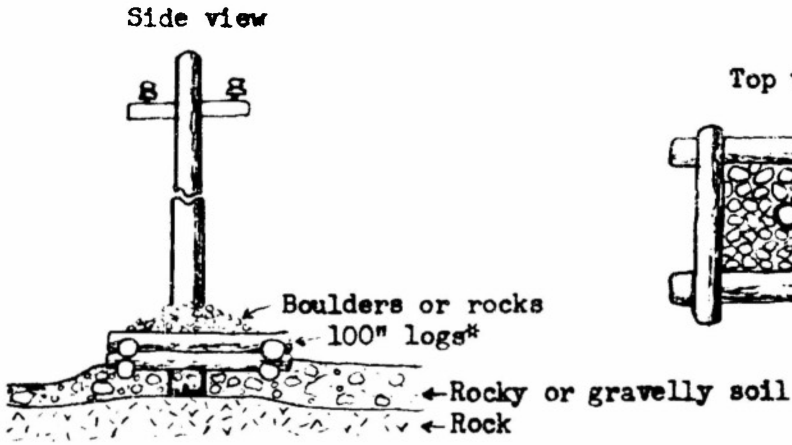
Peaty layer bog

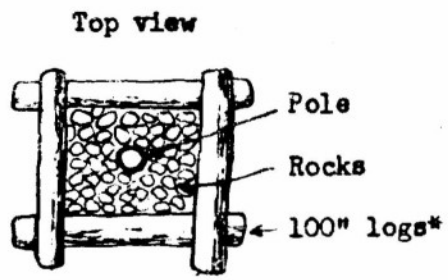
Metal tip (screw) - Metal tip is fastened on the pole and drilled into claypan or other harder material. Used at depths of 3-6'.

Fig. 53

Methods of Erecting Telephone or Power Poles in Crystalline Rock Areas

3. Shallow soil or no soil - Bedrock - Seen in Canada between Sioux Narrows and Emo.





*The reason for 100" logs is that they are the standard length cut for pulp logs in the area.

Fig. 54

Fig. 55 - Logging trail cleared through the forests in the Pine Island part of the Koochiching Area. An old beach line is being followed.

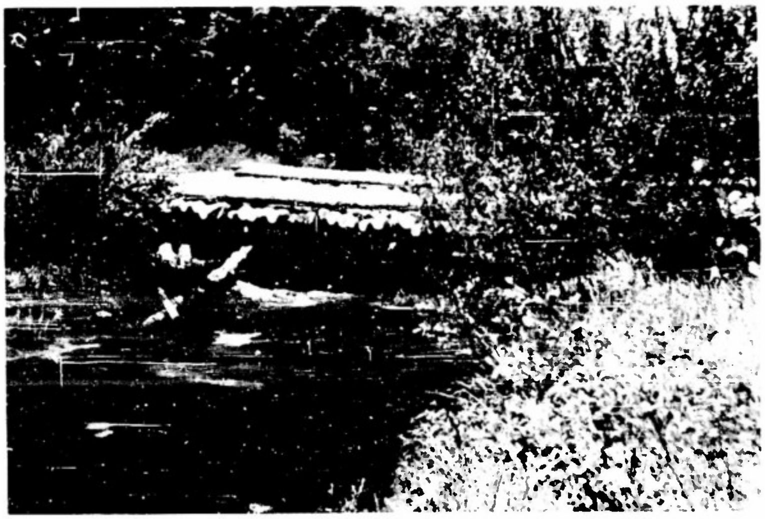


Fig. 56 - The bridge shown here is the same one shown in Figure 55. It has been built across a drainage ditch. Building materials were supplied by the surrounding Pine and Spruce trees.

Fig. 57 - During the spring season, when the ground is starting to thaw, such signs are common. Roads may be impassable due to mud or water. During this season trucks would ruin the road surface by sinking to depth of thaw.

Fig. 58 - Load limits are set for all trucks, even Federal Highways, during the thawing season. The limit is determined by the kind of area through which the road has been built. The lowest limits are placed on those extending through swamps, marshes and bogs.

Fig. 59 - This highway, which extends from International Falls to Baudette, closely follows the south bank of the Rainy River. It has been built on the better drained and drier lands between the river and the Beltrami Swamps in the Koochiching Area. In the summer, which is the season of greatest rainfall, the ground often becomes water logged. During such periods the river bank often slips or slumps, thereby causing the land to move for as much as 100 to 200 feet from the edge of the river. The movement of vehicles over the roads aids nature in cracking and breaking the best of paving materials.

Fig. 60 - The same road break as shown in Figure 59 after a period of four months.

Fig. 61 - Path cleared for power line through Alder swamp shows water at the surface. Clearing located 4.5 miles south of Minnesota State Highway No. 11 on County Aid Road No. 15.

Fig. 62 - Path cleared for power line through taller Alder and Poplar. The surface is dry but water is within six to twelve inches of the surface. Clearing located 2.3 miles south of Minnesota State Highway No. 11 on County Aid Road No. 15.

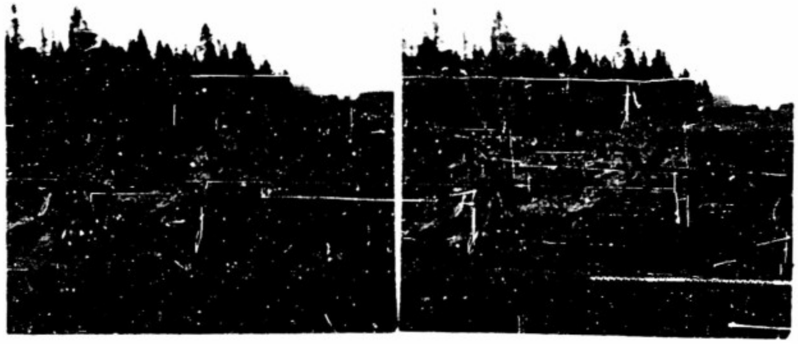


Fig. 63 - Path cleared for power line through Black Spruce. The water table is less than a foot from the surface. Clearing located 2 miles south of Minnesota State Highway No. 11 on County Aid Road No. 15.

Fig. 64 - Path cleared for power line through Poplar. Area is somewhat drier than those shown in Figures 61, 62 and 63. Clearing is located one mile south of Minnesota State Highway No. 11 on County Aid Road No. 15.

Fig. 66 - Road fill through a peat bog 4 miles south of Sioux Narrows, Ontario. Peat face on the right.

Fig. 67 - Water standing in the road after a light shower. Since the road extends through a swamp area the water cannot be absorbed rapidly. Road is very slick.

Fig. 68 - Road covered by water during the spring thaw. Due to the frozen subsoil the water cannot be absorbed. Two days after this photo was made water closed the road with its depth. Often such road blocks remain for several days.

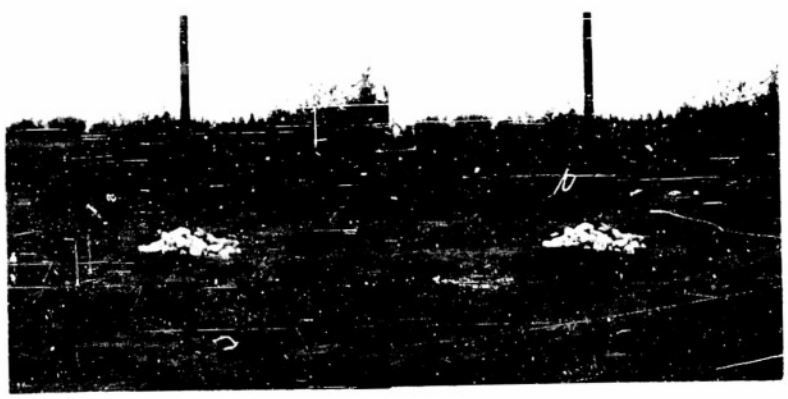
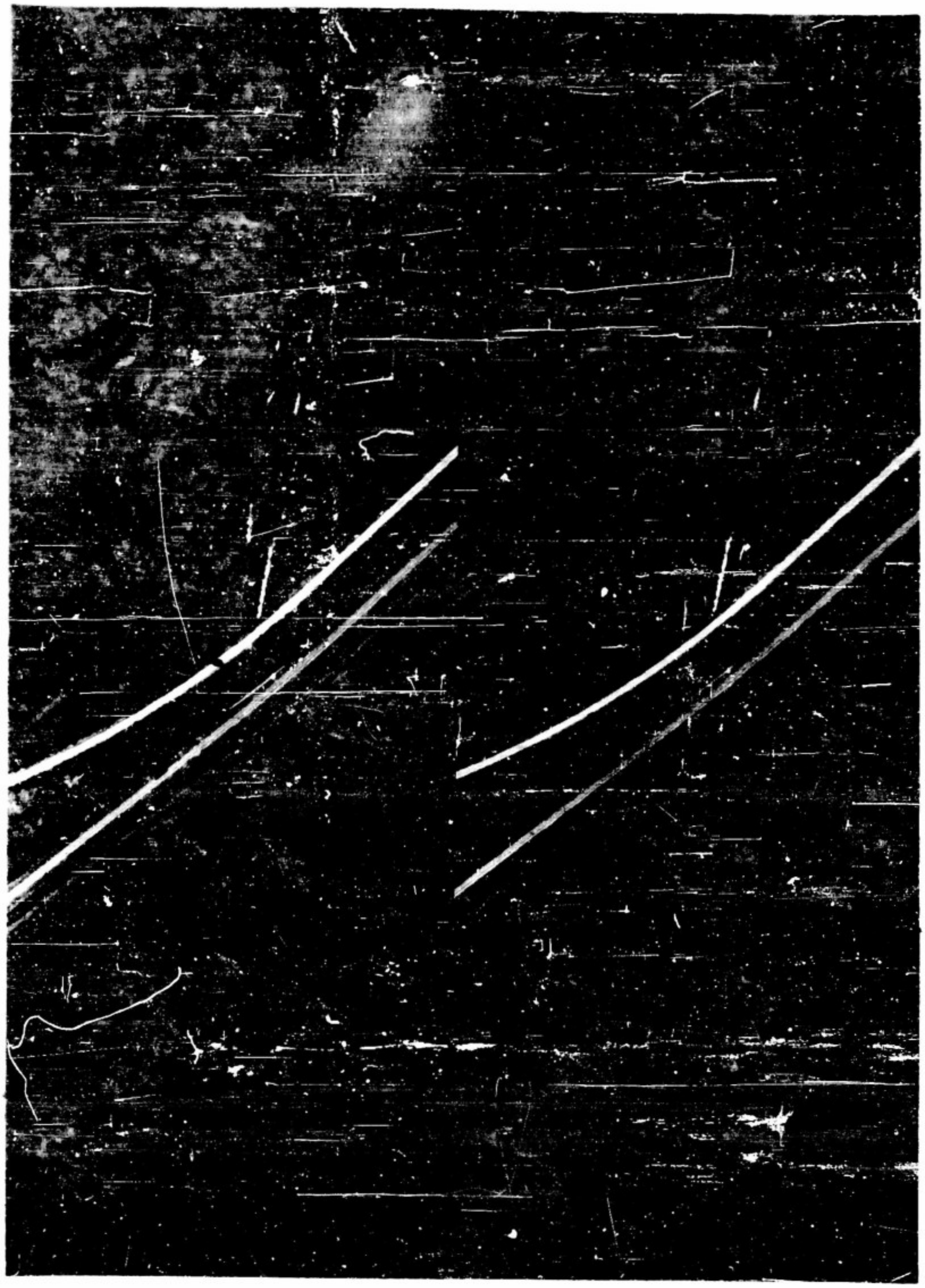


Fig. 69 - Bottom bracing for a power line built through a swamp along the Kings Highway in Ontario.

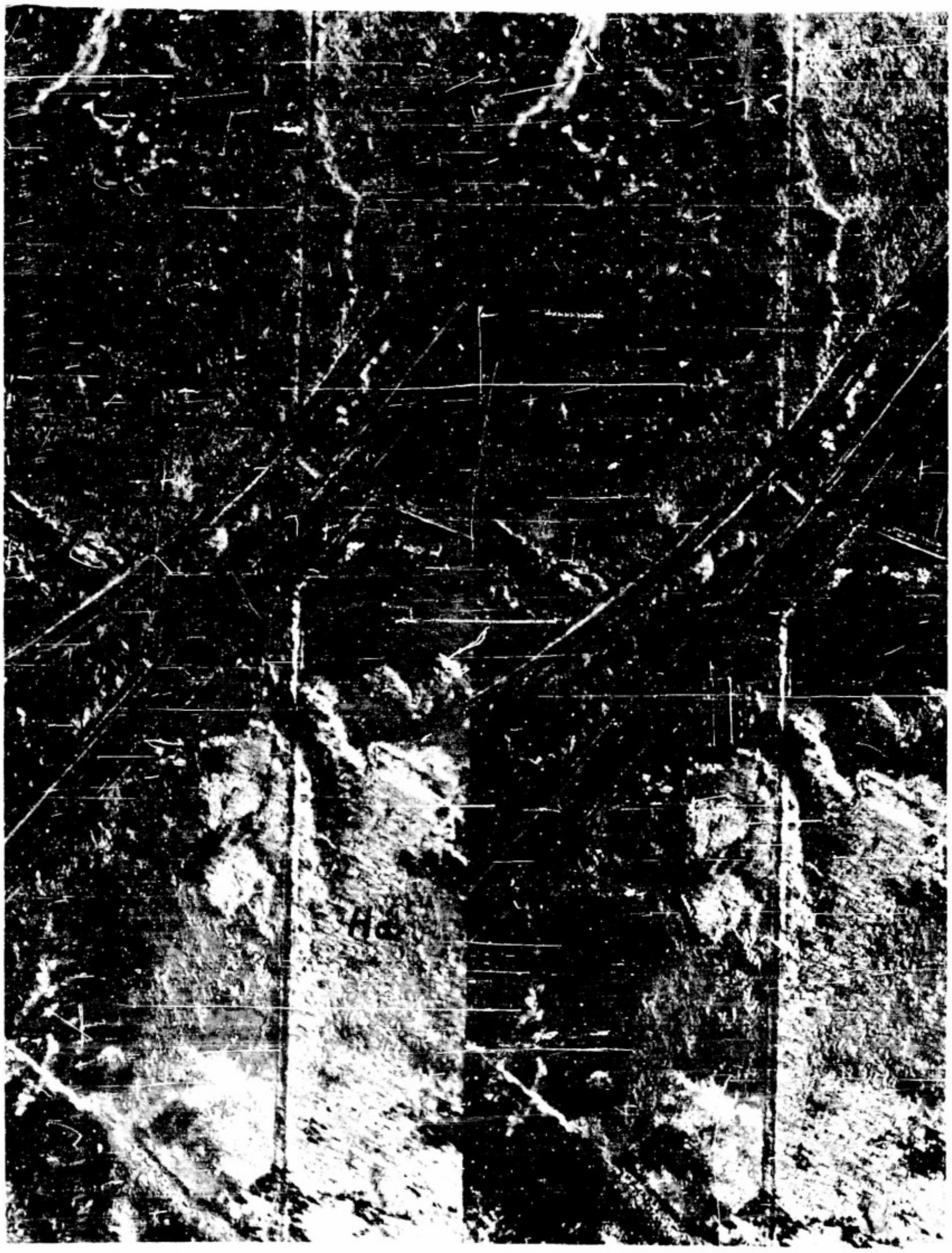
Scale 1:7,500

Fig. 70 - HUBBARD AREA. In many places lakes are separated from each other by short rivers that flow across low, marshy bottom lands. In such cases it is necessary for roads and highways (1) and railroads (2) to construct fills and bridges. Where the adjacent land is high, and cuts have to be made, the excess material can be used in the fills. Trails (3) in the rougher areas follow the ridges, or higher ground, and avoid the connection between the lakes. The lakes, where the water is still, are covered by ice. Where the flow is rapid enough to prevent freezing, as that from Benedict Lake to Kabekoma Lake, the water will probably have a very dark tone.



Scale 1:10,000

Fig. 71 - ITASCA AREA. Deep fills are necessary when roads (2) and railroads (3) are built through swamp (Sw) areas. The tone of the roads and railways will vary with the type of covering on them. Drainage ditches (1) may also be present. The ditch, if water is in it, will probably be very dark. However, as shown on the photos, water may run the tone scale. Study this stereo pair in conjunction with Figure 72.



Scale 1:6,800

Fig. 72 - ITASCA AREA. This figure is of the same area as Figure 71. It was, however, photographed during the winter season. The Popple (P) island is visible in each. These trees are growing on a high, dry, sandy area in the swamp (Sw). Tamarack (T) is found on lower, wetter ground than the hardwood growth in which Aspen is dominant (Ha).

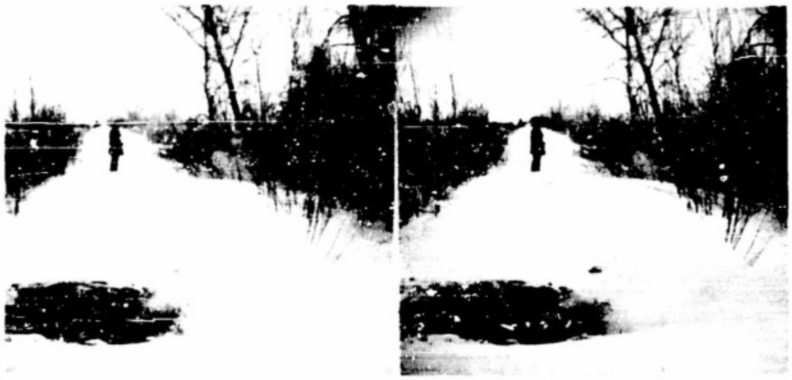
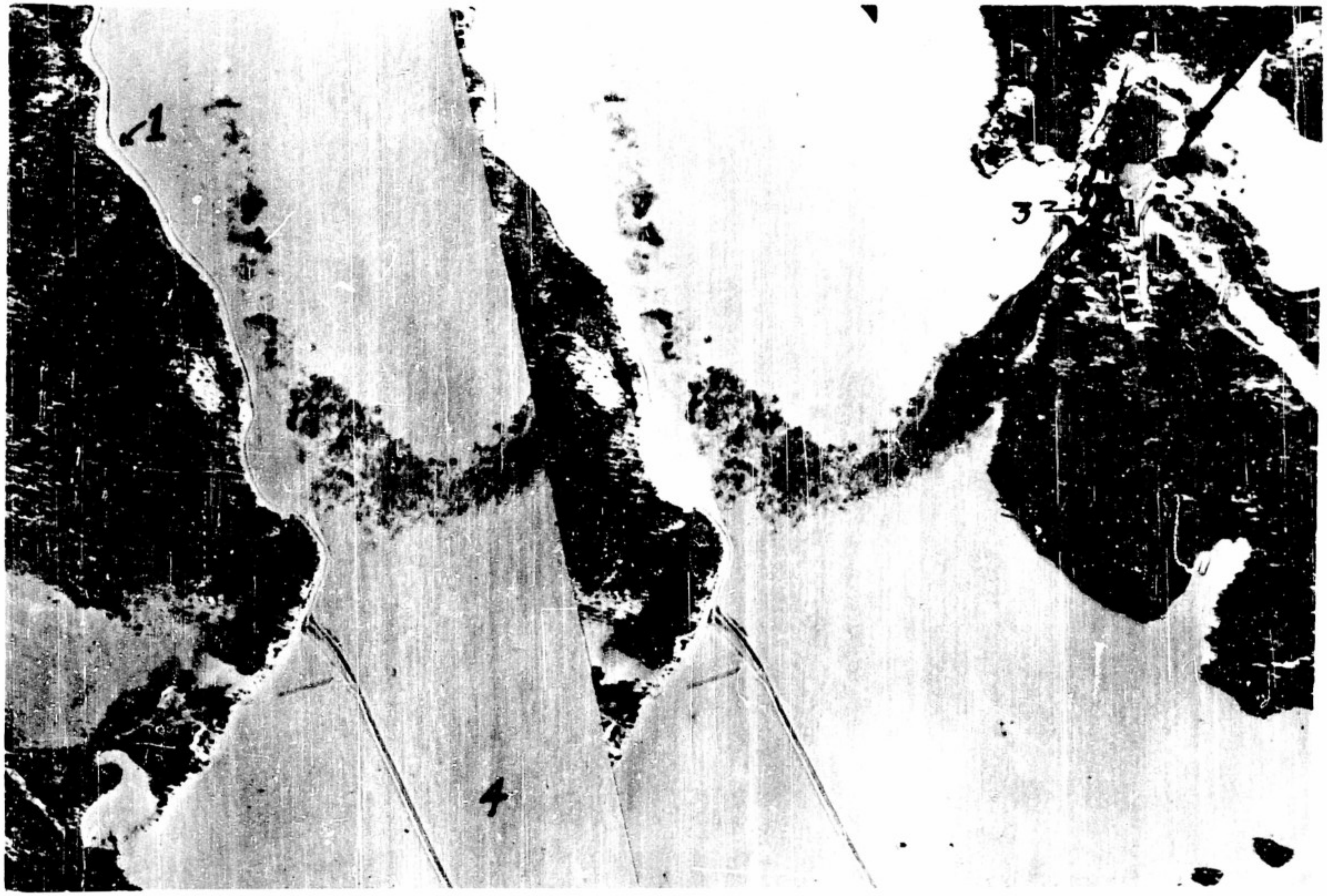


Fig. 73 - Peat fire burning under a road in the Koochiching Area. Once a fire is started it smolders, or burns slowly, until the peat is burned out or enough moisture is absorbed to smother the fire.

Fig. 74 - Same place as Figure 73, looking in the opposite direction, three months later. Fire is now out due to thawing conditions. Road, however, has been made useless without additional work. Should snow cover the road again this would be a dangerous trap.



Scale 1:7,500

Fig. 75 - ELY AREA. During the winter season, after the lakes have frozen, their surface is often used as trails or roads (1). By keeping the snow shoved to the sides the ice freezes thicker. Areas of thin ice (2) have a different tone and texture than the areas of solid ice (4). Areas of open water (3), such as that below the dam, usually appear black.

Fig. 76 - Warm springs sometimes appear in shallow lakes or near the shore. In such cases the ice covering may look like a solid covering yet be very thin. This small opening is about four feet long and twelve inches or less in width. Such places are almost impossible to pick out on aerial photos.

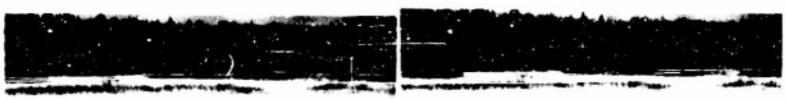
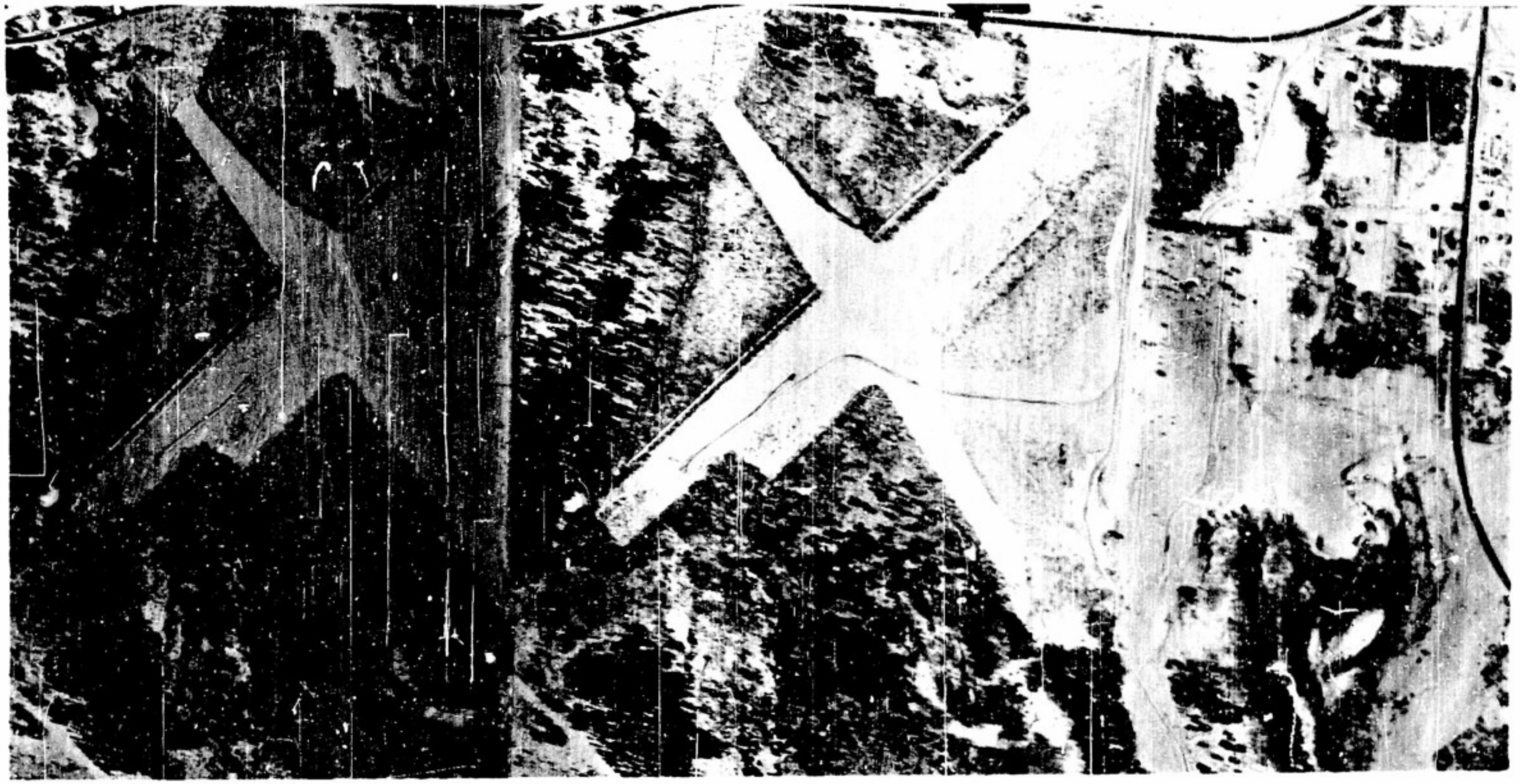


Fig. 77 - The darker line is thin ice with a warm spring under it. These lines will not show in aerial photos.

Scale 1:20,000

Fig. 78 - KOOCHICHING AREA. An airstrip (3) will stand out in any aerial photo but especially so in a forest area. This strip, located in the Pine Island part of the Koochiching Area, will accommodate only small planes used by the rangers at the forest station (4). Roads (1) and trails (2) are often impassible, especially during the thawing season and after heavy rains.



Scale 1:7,500

Fig. 79 - ELY AREA. The easiest object to identify on any photograph is an airfield or airstrip. This one, just south of Ely, Minnesota, is built on the edge of a swamp. Since no buildings appear near the runways, and since the brush and trees have not been completely cleared from the runways, it is easy to conclude that little use is made of the field. Extension of the runways is blocked by rock outcrops (Ro), swamps (Sw) and drainage ditches (1).

Scale 1:20,000

Fig. 80 - KOOCHICHING AREA. Logged over areas (1) are very easy to identify due to the criss-crossing road pattern of both the principal and the secondary road paths. In most cases the secondary roads or paths will be almost parallel with each other. Numerous scattered but smaller trees will be left standing unless the area has been completely cleared. Usually the edges of the logged area are in straight lines rather than the irregular lines presented by tree growth. Aspen (A) is growing with Spruce. The Aspen in this case are easily identified because of the white appearance they make. A stand of almost pure Spruce (S) and the swamp (Sw) are also indicated on the photo.

Chapter VI

THE ELY AREA

The Ely Area is located in that part of northeastern Minnesota which is commonly referred to by the inhabitants as the "Arrowhead." This area differs from the other three type areas in that it has a higher elevation, rougher topography, more exposed rock outcrops, and is one of the least developed parts of the United States. Although lumber companies harvest large amounts of timber from this part of Minnesota some of the "Arrowhead" is still in virgin timber. Some few years ago the Quetico-Superior forest area was established. It is the ideal place for a canoe-hiking type of vacation. Many places including large and comfortable resorts cannot be reached by overland methods, thus the principal way to get into many sections is by boat. The entire Ely Area is a mass of lakes, forests and swamps intermixed in the ridges and valleys that have been left in this old Superior Highland Area.

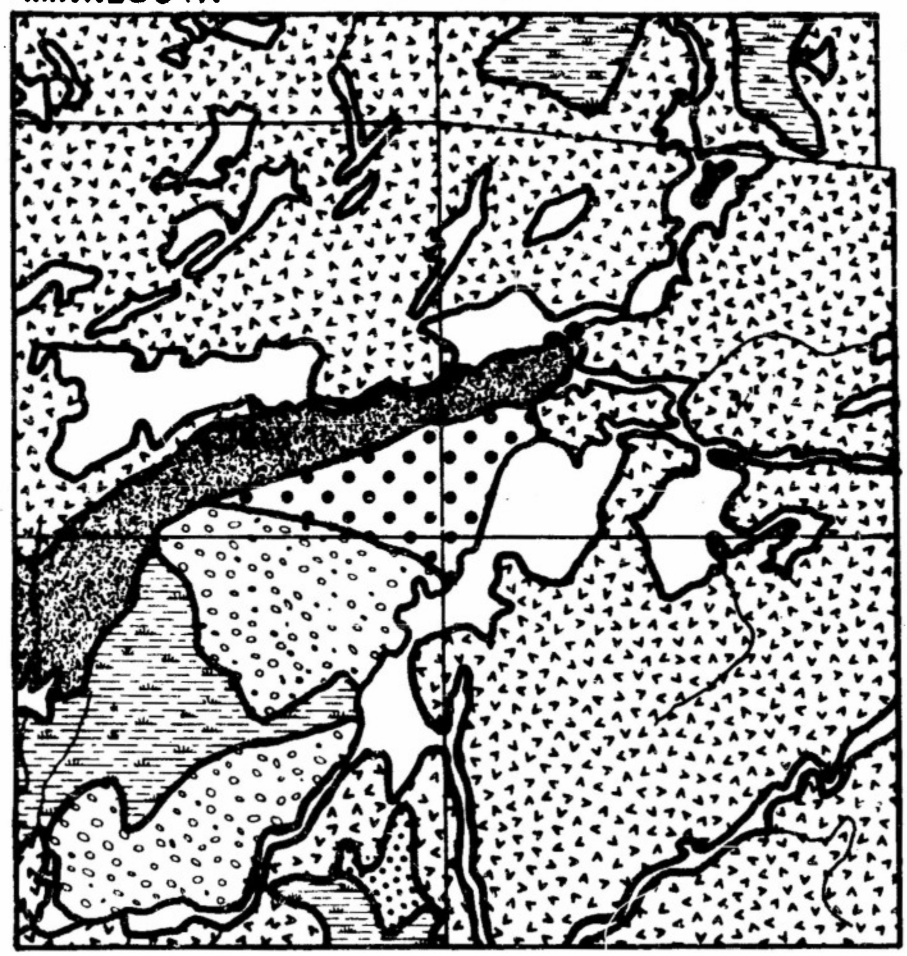
Geology

Dr. Wallace W. Atwood in his article "A Geographer Looks at the Quetico-Superior Area" made the following statement about the geology.

> Here the geologist finds exposed at the surface the roots or stumps of very ancient Precambrian Mountain Ranges. The rocks are granites, gneisses, schists, greenstones and basaltic intrusions. This is a region where rock masses five to ten miles in thickness, that were folded, broken and crushed during mountain making movements, have been removed by erosion and washed into inland seas to form sandstones, conglomerates and shales that mantle much of the interior of the continent.
>
> During the long erosion period when the ancient mountains were removed the streams reduced the surface of the land to a rolling

ELY AREA

MINNESOTA



Ma- 3

MILES

0 1 2 3 4 5 6

OUTWASH GRAVEL IN PLAINS AND APRONS

SANDY LANDLAID MORAINES

SANDY LAKE WASHED TILL

ROCK OUTCROPS

TILL OR BOULDER-CLAY PLAINS

SWAMPS

plain not much above sea level. If, today, in imagination we fill the lake basins and hollows to the monotonously even summit level of the hill tops we reproduce that old erosion surface, a peneplain.

Later this region was uplifted and the rejuvenated streams designed the gently rolling surface developing a drainage pattern with major valleys and many smaller tributary stream courses.*

Map 3 shows the present surface geology of the Ely Area. The dominance of rock outcrops is at once noticeable. Mixed with these are lakes of varying sizes and shapes and to a large extent connected through valleys of varying sizes. A few large swamp areas are immediately noticeable, however, smaller areas of swamps exist in numerous places within rock outcrops. The city of Ely is built on one of the sandy moraines that extends through the western part of this area. Numerous other surface formations such as sandy lake washed till and boulder clay plains are also observed within this area.

Topography

The land surface in the "Arrowhead" country includes the highest elevations in Minnesota. Some hills rise 2,200 feet above sea level or 1,600 above Lake Superior. This high land is rocky and stony. The hills are steep and strewn with fragments. Map 4 shows the land forms in the area used for study. The lack of level land is at once apparent. This rocky formation is among the oldest in the world yet the landscape is young. Drainage has hardly developed beyond the stage of infancy. In some places the surface of the landscape is naked rock with hollows and lakes, swamps and meadows interspersed. Boulders of huge sizes

*Wallace W. Atwood, A Geographer Looks at the Quetico-Superior Area, (Chicago, Quetico-Superior Committee, 1950) p. 2.

Map 4

ELY MINN. AREA

are strewn in wild profusion. Hundreds of lakes lie in basins that have been hewed out of hard rock floor.

In general three types of glacial action gave rise to the basins where lakes might form. They were by (1) scouring out basins in solid rock, (2) by damming up drainage channels, or (3) by having great chunks of ice break off, then covering these with soil so that upon the melting of the ice blocks, shallow or deep kettle hollows in which water collected were left.* After the glaciers melted, vegetation began to appear. Probably the pioneers of spruce, fir and jack pine were among the first species. Gradually they took possession of all types of surfaces building up the quality of the soil as one generation after another died.

Swamps and Bogs

As time passed, plants matured and died and new ones took their place. Sediments filled the lakes, the water became shallow and the seed beds moved outward into the former lake proper. During the process of lake filling, vegetation of greater bulk encroaches upon the banks until finally there is only one small central pool remaining. Thus the outer belt of the former lake has been transformed into a coniferous forest, possibly of spruce underlain with a light covering of sphagnum mosses or a dense cover of small shrubs like Labrador tea or Leatherleaf. From that time on the basin is known as a bog or it may be termed a muskeg.

Bog soils consist almost entirely of organic matter. Most of it

*"In general the depths of the lakes is equal to one-half the heights of the surrounding country." J. "Bill" Trygg, U. S. Forester, Ely, Minn.

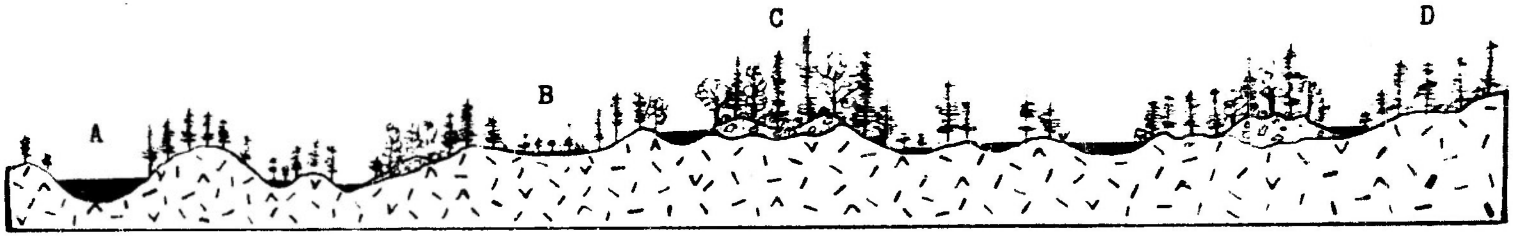
is from the accumulation of plant remains which form peat. Most of the present bogs began as lakes or ponds following the glacial time. The initial filling of the basin may have been rock flour or fine sand which contained very little or no organic substances. Most of the bogs in the Ely Area have such an initial sediment. At present very few of the bogs are deep because the region is young and basins which may someday be deep bogs are still lakes. Examples of these bog-swamp areas and their nearness to lakes can be seen in Figures 83 and 84.

Vegetation

Hardwoods of various species are prominent in the Ely Area. Aspen is widely scattered and occupies many of the hill tops and some of the drier land adjacent to the swamp and bog areas. Paper birch and northern mixed hardwoods are also prevalent. Formerly the dominant coniferous vegetation of the area was white pine. Mixed with this white pine were Norway pines, white and black spruce, and a few jack pines and balsam fir. With the removal of the white pines, jack pine has rapidly taken hold, influenced, no doubt, by burning the cut over areas. Heat aids the dispersal and germination of jack pine seed. Immediately following the cutting, hardwoods such as aspen, birch, poplar and brush such as hazel may outgrow the conifers. Jack pine is often found dispersed through the hardwood areas especially in mixtures with aspen. Spruce is frequently seen growing on the hill sides and even on the ridge crests in competition with other species. White spruce and balsam fir as well as black spruce and balsam fir occupy many acres of land together. Jack pine, however, is the dominant upland conifer.

Ely Area

A. Oblique view of typical ice-scoured crystalline rock area. Lakes occur at various elevations.



A - Lake   B - Bog   C - Glacial drift   D - Thin soils over crystalline rock

B. Cross-section view of an area similar to A above. Vegetation is an indicator of surface features. Crystalline rock areas with thin soil support stands of conifers (climax-balsam fir). Glacial drift supports mixed stands of conifers and deciduous trees. Bogs support stunted spruce.

Fig. 81

In the lowland areas black spruce is the most common species. Some tamarack and white spruce also grow in the Ely swamps. The black spruce, which is the best indicator of a swamp region, stands out on the infra-red photos as shown on Figure 84. White cedar also occurs in wet areas, especially around the edges of bogs, springs and seeps where moving water is available. The swamps in the area are easily detected from stereo pairs because of the meandering streams, stunted growth of some of the trees particularly as the middle of the swamp is reached and the numerous game trails that follow the edges or cross to the drier parts of the swamp area.

Transportation

In the Ely Area motor roads are not highly developed because of the lack of population. The general topography offers more resistance to road building than in any of the other three areas studied in detail. The igneous rocks and the ridge and valley system along with the numerous bogs and small swamps make road building difficult. The exposed bedrock offers more resistance to road building than the swamps. The rock outcrops take a great deal of blasting for road cuts but usually a fill of only three or four feet is necessary in the shallow bogs. Figures 83, 84, and 85 show roads built in the swamp areas. In most cases the roads follow along the edge of the swamp as much as possible, cutting across it at its narrowest point. Such igneous areas as this one furnish vast quantities of good road building materials. In some places only the top soil has to be dragged away, and the road built upon the solid granite underneath. Such roads have no load limits. The only time that there

may be difficulty in using them is during the spring thaws.

Ice begins to form in early November and becomes safe for any kind of vehicles by the first of January. Ice travel usually ends by or around the first of March. After that date ice travel is extremely hazardous. Ice is usually out of the lakes by mid-April. Boats are used usually from the first of May to the first of November. Because of ice conditions boat travel is not recommended for six weeks prior to January 1 or six weeks after March 1. The use of ice in winter is hastened by removing snow so that the cold air can freeze the ice to greater depths. Blue ice one inch thick will support individuals, six inches thick it will support a truck loaded with logs. It is not unusual for the ice to reach a thickness of three feet.

During the winter, loggers travel over straight trails to the timber. They must wait until the latter part of December or the first of January, however, to cross the muskegs and bogs because of their heat retaining ability. The snow trail across the bog is first tramped down by foot. A small tractor is then run over the road to further pack it before actual usage starts.

Cultural Factors

Cultural factors in the Ely Area vary all the way from resort cottages along the edge of the lakes to a city the size of Ely. A few smaller towns have been formed but are declining in importance. One large dam has been built across one of the rivers flowing into Fall Lake. This dam harnesses water for the generation of electrical power (Figs. 86 and 87). Where electric power lines travel through the

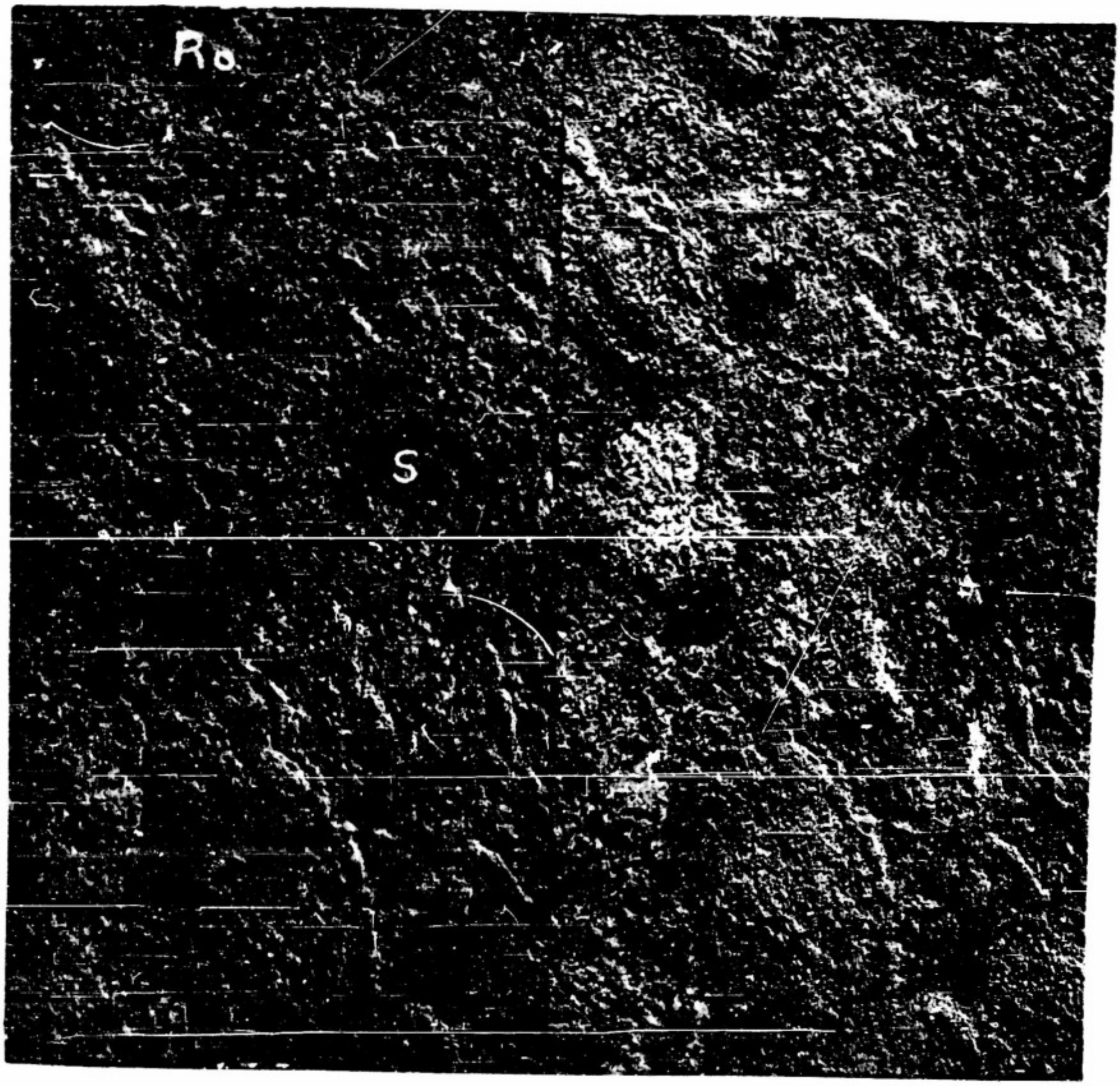
country they are at once apparent on the photograph because of the necessary clearings. Figure 86 taken in 1940 shows two parallel cleared paths for power lines, however, Figure 87 of the same area taken in February of 1953 shows that the center row of trees has been cleared. No power line poles are visible on the earlier photograph, however, it is quite certain that some were in existence at that time. The power poles are quite visible in Figure 87 as indicated by their shadows.

Almost no agriculture is practiced in the Ely Area. Stoniness, topography, the short growing season and the high rainfall during the planting season all combine to make this activity unprofitable. Hay is the principal crop of the area. Local gardens produce a variety of vegetables.

Christmas tree cutting of both the wild and planted variety is a common activity during the fall and early winter. Iron mining, trapping and fur farming are also sources of employment.

Conclusions

Lakes and swamps in areas such as the Ely Area are not handicaps to the movement of troops or supplies. The one difficulty to be encountered is that all swamps are not at the same elevation. They may occupy small pockets high on the side of a hill as well as the valleys between the hills. Because of the numerous hardwoods and the usually quick growth of coniferous trees, concealment and storage areas can be found without too much difficulty.

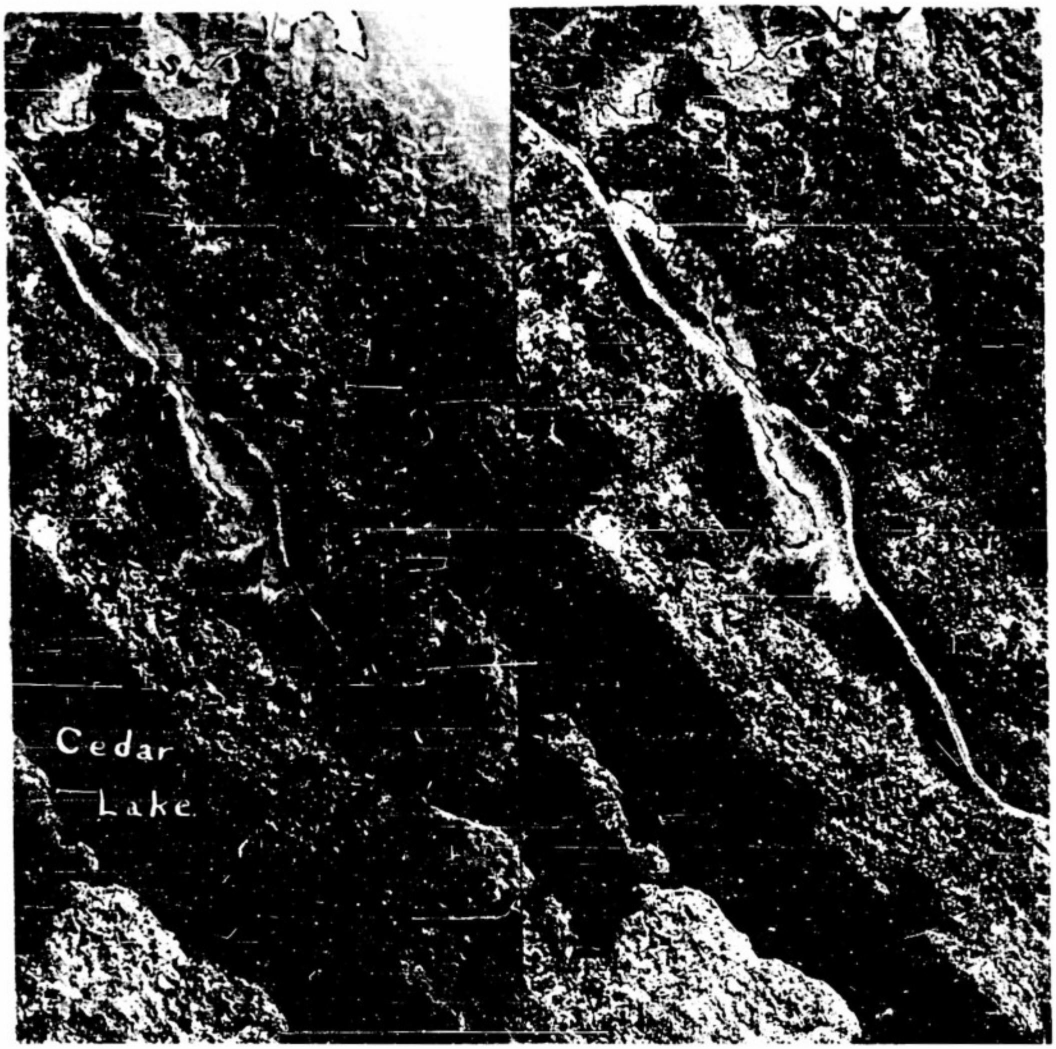


Scale 1:15,840

Fig. 82 - ELY AREA. Areas of rock outcrop (Ro) are common in the Ely Area. These outcrops may be higher or lower than the surrounding land. In most cases they can be identified, however, by the difference in the height of the vegetation or the absence of vegetation. The primary vegetation in this area is northern hardwoods (N), however, areas of Spruce (S) may be seen on some of the roughest and more rugged places. In the lower areas small swamps (Sw) may be developed. Usually game trails (1) can be seen going into the swamp especially if water is available. As shown by this stereo pair there is very little level land and the entire region is one of hills and valleys.

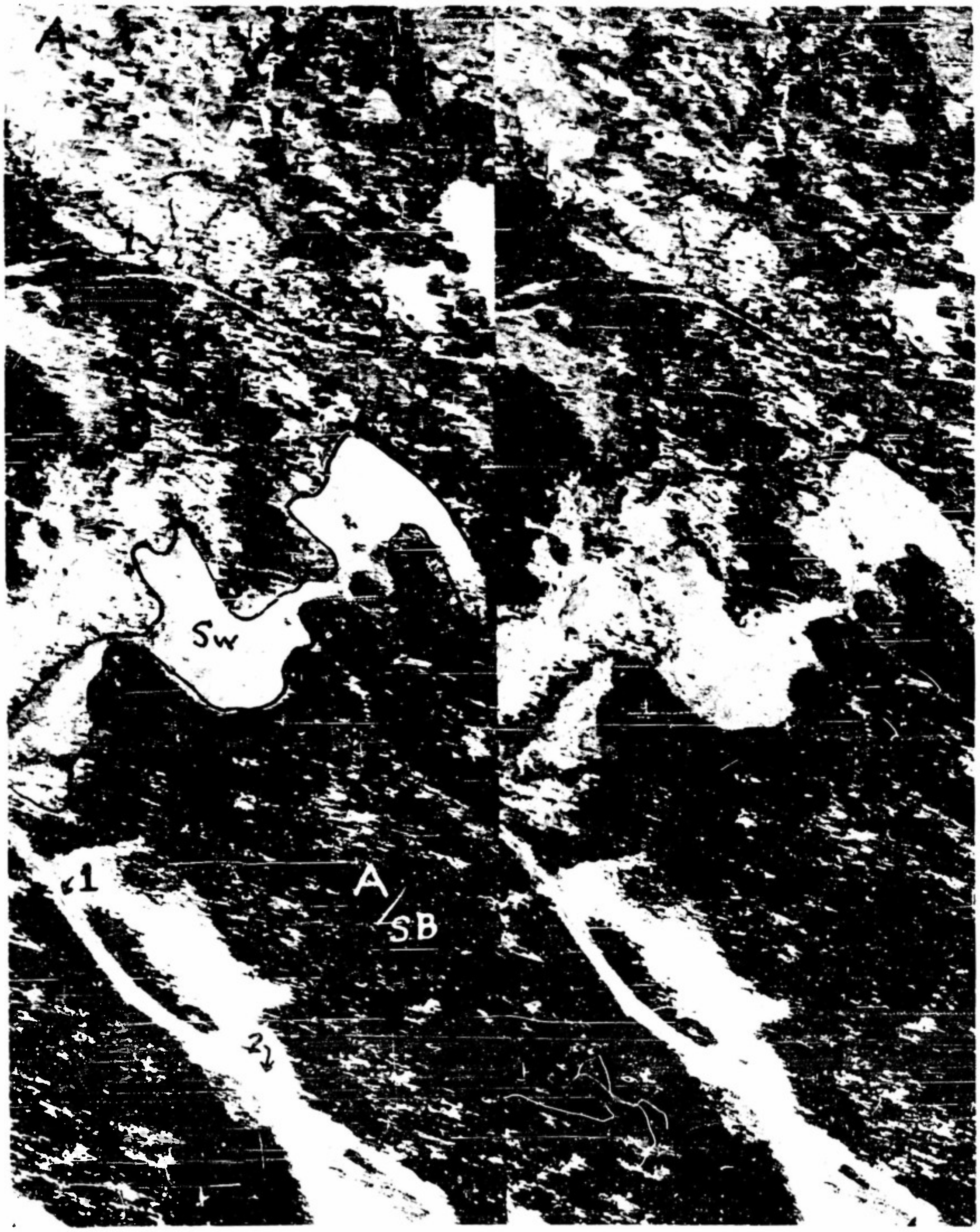
Scale 1:15,840

Fig. 83 - ELY AREA. **Large** swamp (Sw) areas are common in the lower regions adjacent to the arms of lakes. Such areas are identifiable by the greater variation in tone and texture than the forest areas proper. Trails (1) are much easier to locate in the swamps. They are also indicators of the part of the swamp to be avoided except around open water holes.



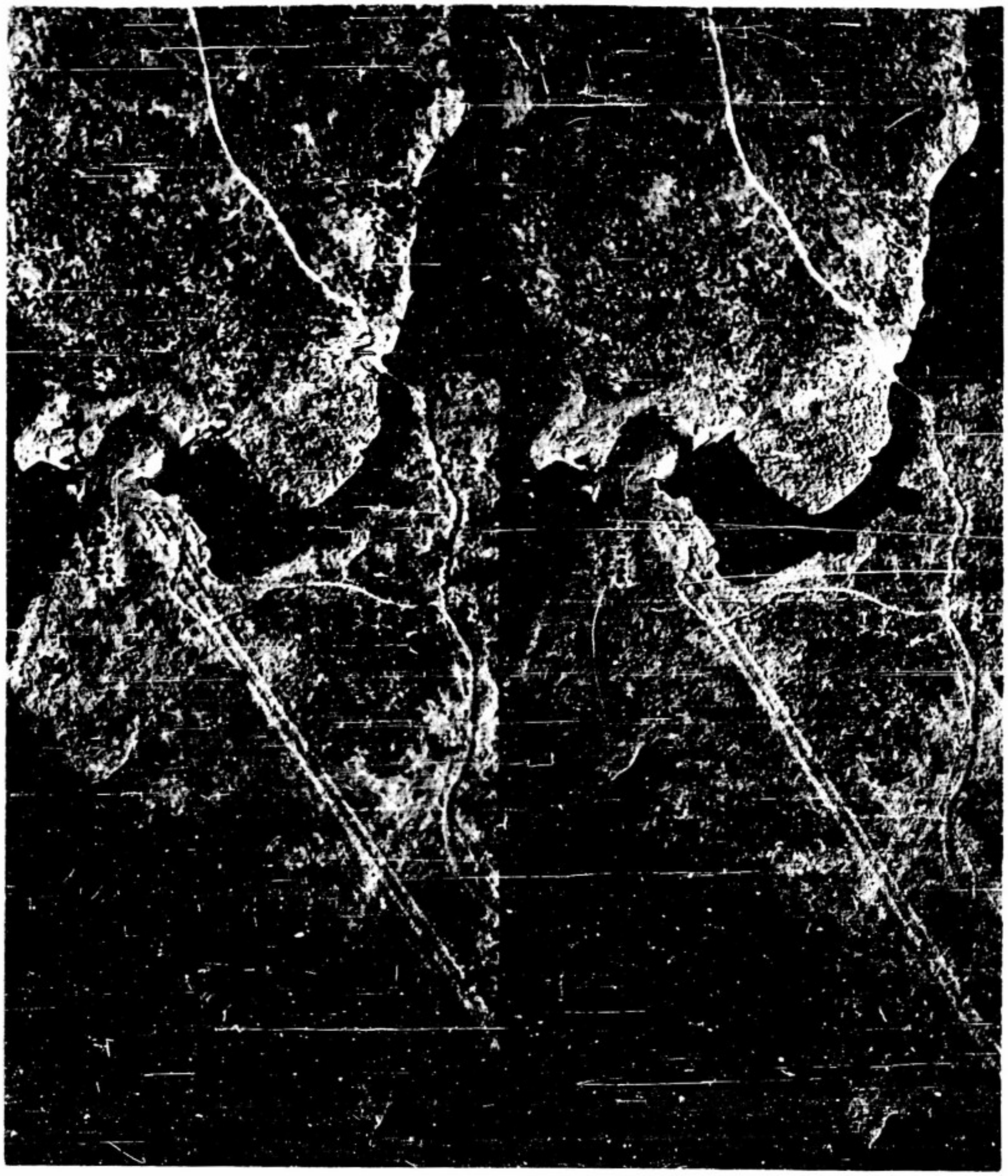
Scale 1:15,840

Fig. 84 - FLY AREA. Swamps (Sw) do not present the problems to road construction in areas of crystalline rock that are presented in other swamp areas. Usually the highways (1) are constructed along the edges of the narrow swamps and cross them at either a narrow or suitable place. In many cases it is easier to build a bridge (2) than it is to put in culverts with a complete fill. Wherever large groups of Black Spruce (S) are found growing together in valleys it is a safe assumption that the area is moist and should be avoided if at all possible. The higher or rougher areas will usually have on them growths of Aspen (A) or in some cases White Pine (Pw). Frequently Aspen with mixtures of Spruce and Birch (A/SB) are also found. Figure 85 shows a part of the same area during the winter season.



Scale 1:7,500

Fig. 85 - ELY AREA. This stereo pair covers a part of the area shown in Figure 84. This coverage, however, was flown during the winter season. Figure 84 is infra-red, while Figure 85 is panchromatic. Roads and trails (1) can be identified without difficulty. The bridge (2), however, may appear as a part of the road due to the depth of snow beside it. In the swamp (Sw) only a part of the river bed can be followed because of the snow and ice covering.



Scale 1:15,840

Fig. 86 - ELY AREA. On summer infra-red photographs cultural features can be identified without a great deal of difficulty. Roads (1) represent definite clearings through the forests because of the very rough terrain over which they are built. Very few of them will continue in a constant direction for long distances. Power lines (5) however, do extend in straight lines regardless of the topography. In this instance the trees between the power lines have not been cleared. Bridges (2) are constructed across the narrow arms of the lakes. In some instances where favorable sites present themselves dams (3) are built and power installations (4) put into operation. The power generated in such places furnishes electricity to the nearby small towns and villages or to the numerous resort cottages on lakes within the area. The principal vegetation is mixtures of Spruce and Fir (SF) or Spruce, Fir and Pine (SFP).

Scale 1:7,500

Fig. 87 - ELY AREA. This stereo pair is a panchromatic view of approximately the same area as shown on Figure 86 in infra-red. Since Figure 86 was taken about ten years before Figure 87 the similarity is remarkable. The roads (1), dam (3) and power installations (4) remain as before. No change is noted in the vegetation cover. The old bridge (2) still remains, however, a new one is being built nearby. The big change has been the clearing of the center row of trees from the power line path and the substitution of steel power poles for wood. The shadows cast by these new poles (6) identify the type used.

Fig. 88 - Dead Spruce swamp about 4 miles east of Winton. In the winter conditions for travel are much more favorable through such an area than in the summer or fall season.

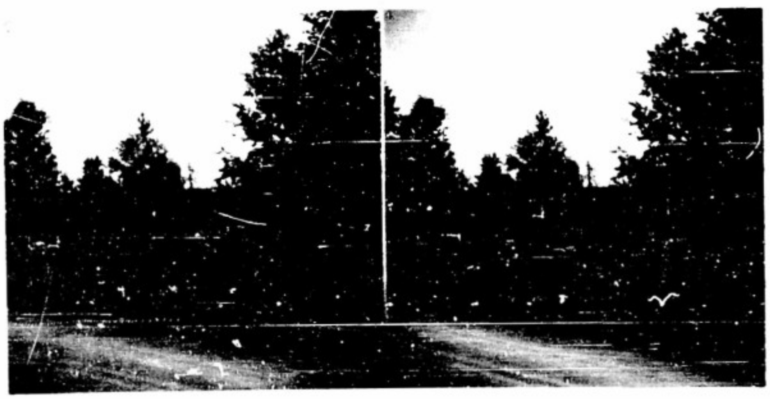


Fig. 89 - Live Spruce in the foreground with the dead Spruce swamp in the background located 2.8 miles northeast of the Garden Lake Bridge (Bridge shown in Figure 86).

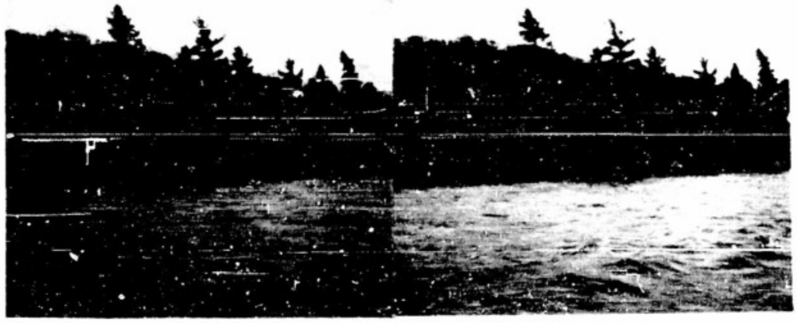


Fig. 90 - Large rock outcrop along shore of Basswood Lake. Vegetation cover is primarily a mixture of Red and White Pine. During the summer season it is often difficult to distinguish these rock outcrops because of the vegetation cover.

Fig. 91 - Rock outcrop 2.7 miles east of Garden Lake Bridge. During the winter and spring seasons such rock outcrops are easy to distinguish because of the lack of leaves on the trees.

Scale 1:7,500

Fig. 92 - ELY AREA. A part of the city of Ely is shown in this stereo pair. The enclosed area is a ski jump. Since all such jumps, whether in the United States or other parts of the world are similar, they can be used as definite identification points. They would indicate regions of cold winters, heavy snows and a moderate to dense population for such an area. The more used paved roads will have the snow and ice either cleared away or worn through so that they appear as dark lines. The less used roads and streets will still be snow covered. Usually some clearing has taken place as shown by the snow banks. The varied shadows cast by the leafless trees should be noted.

Fig. MULTICOLORED

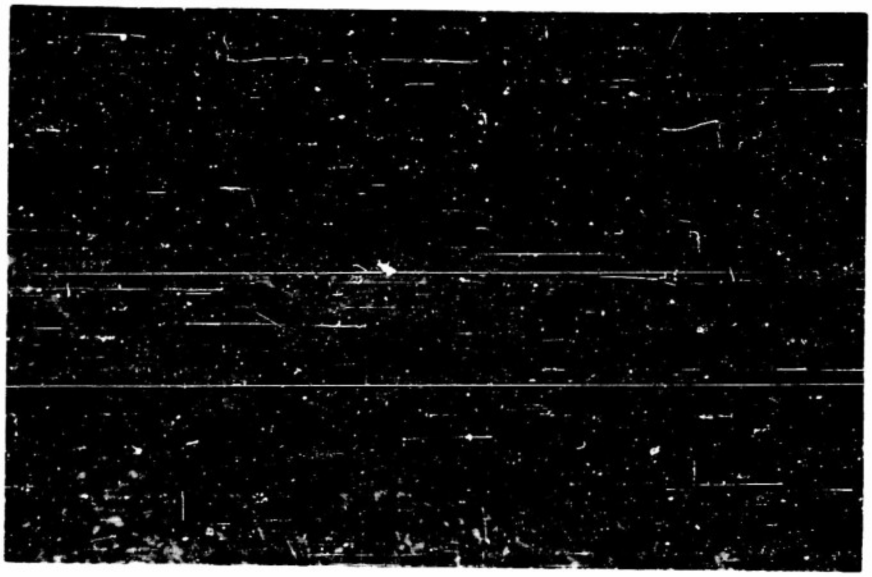


Fig. 93 - Rocks, boulders and erratics are common in all glaciated areas. The size may vary from less than a pound to more than several tons. Many of the erratics and large boulders are buried deep in the soil. During a summer season when the trees are leaved out and vegetation is in full growth they are often very hard to distinguish. Many have changed color due to weathering and erosion so that there is almost perfect camouflage between the boulders or erratics and the vegetation around it. The erratic shown in this picture is approximately 50 feet in length and at its highest point is almost 6 feet above the ground.

Chapter VII

THE HUBBARD AREA

The Hubbard Area is located in the north central part of the state of Minnesota. It is just east of Lake Itasca, which is one of the sources of the Mississippi River. The principal landform in this area is a large terminal moraine. This feature is due to the concentrated depositions of drift at the ice edge during extended pauses in the general retreat of the ice front. The area is extremely rough and pock marked. Only small amounts of the land are suitable for agriculture. Lakes of varying sizes are seen from any highways or trails which one may follow.

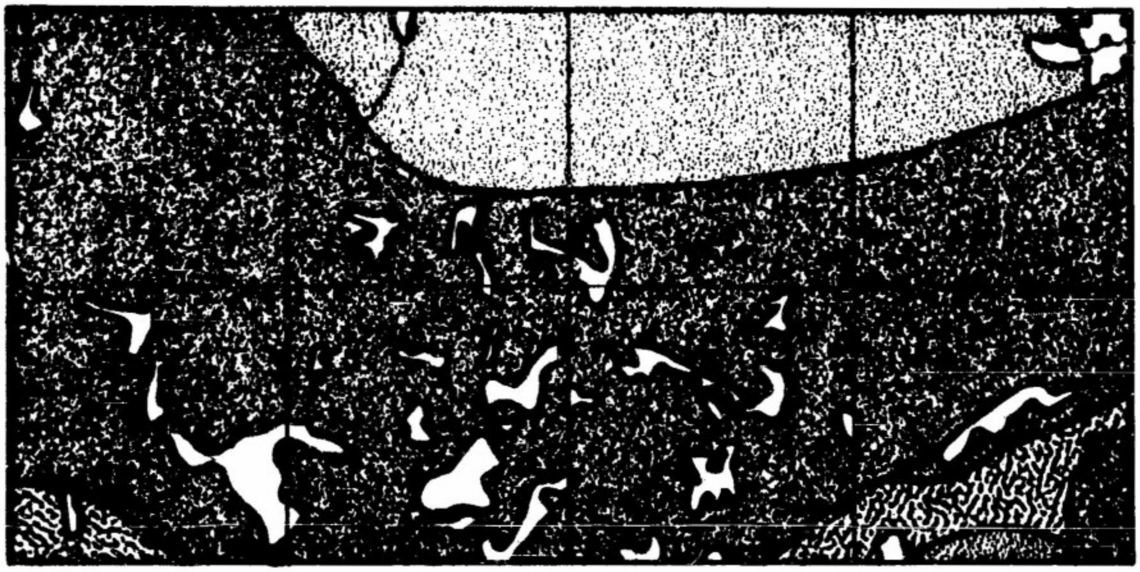
Geology

The surface geology of the area is shown on Map 5. As is readily noticeable, the dominant feature is the sandy landlaid moraine which extends across the area from east to west. Bordering this moraine to the north is a region of clay landlaid ground moraines and a small outwash plain. To the south is a sandy outwash plain plus a part of a clayey landlaid moraine. With each advance the ice brought large quantities of rock fragments, partly as stones varying in size from pebbles to huge boulders, but mostly as finer material such as sand, silt and clay.

Large lakes as well as numerous smaller ones were formed during the glacier period. At each pause in the general retreat of the ice front a ridge of hills was built along the ice margin. Ice blocks that became stagnated and detached from the main ice mass were buried under debris that was heaped into the moraines. Later when the main glacier

HUBBARD COUNTY

MINNESOTA



Map 5

MILES

0 1 2 3 4 5 6

SANDY LANDLAID MORAINES

CLAYEY LANDLAID MORAINES

OUTWASH GRAVEL IN PLAINS AND APRONS

SANDY MORAINES AND OUTWASH GRAVEL

retreated, the buried ice blocks melted and left depressions which are now occupied by water. These ice block basins make up the bulk of the lakes in the morainic belt. The small areas of ground moraine and outwash plains are minor features when compared with the central moraine belt in this particular area.

Topography

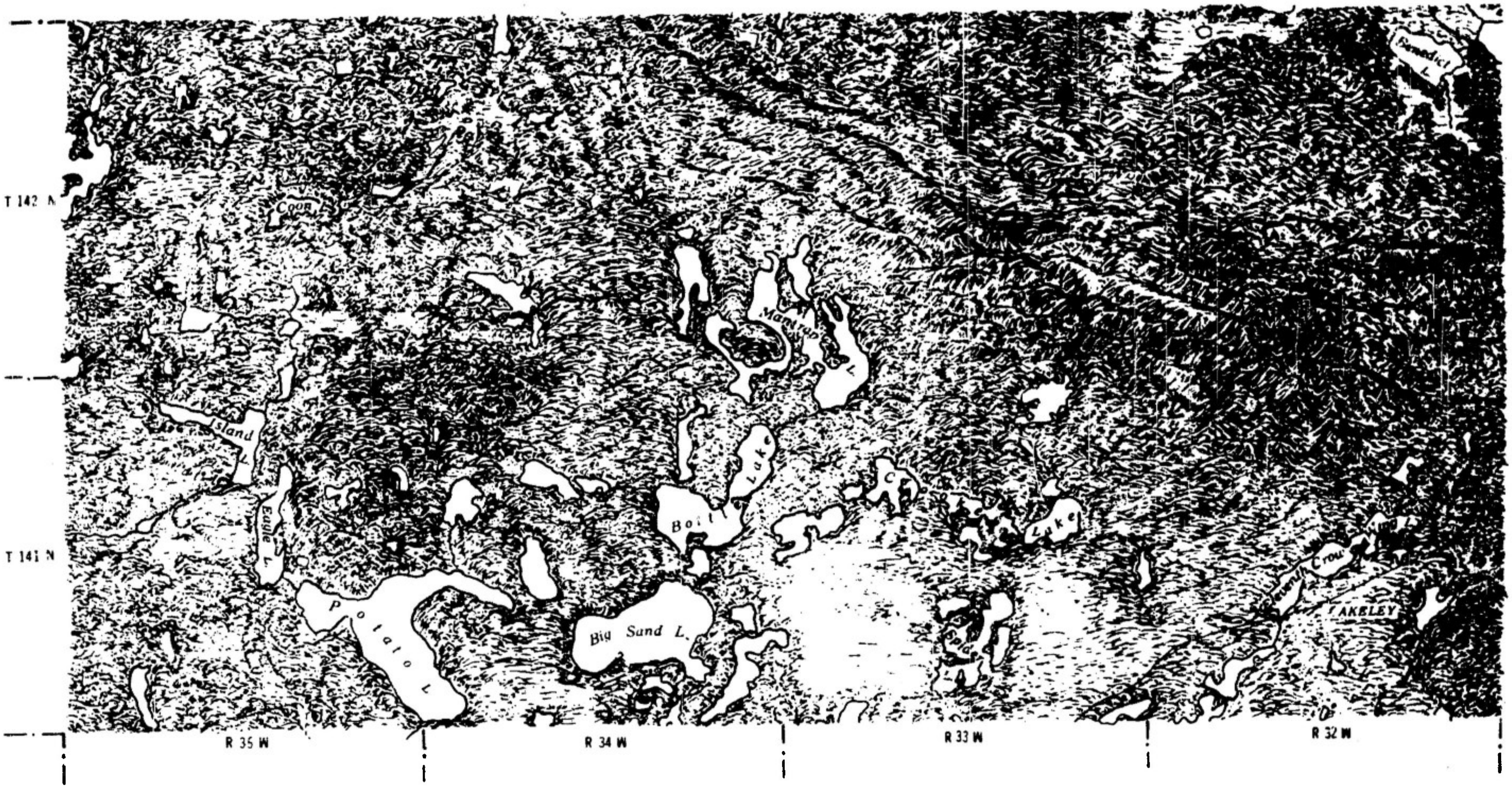
Map 6 shows the landform conditions in the Hubbard Area. The central ridge is sharply rolling to very hilly. Some of the hills have relatively steep slopes and rise as much as 100 feet from their adjacent depressions. South of the central ridge the country smooths out first to rolling hills and then eventually to fairly level plains. The till plain with heavy soils, north of the ridge, has a local relief ranging from five to thirty feet.

Most of the large lakes lie in a belt of gravelly hills to the south and west of the principal ridges. The largest lakes in the area are connected through a series of short rivers and smaller lakes. For example, Mantrap, Bottle and Big Sand Lakes are all connected and drain eventually to the south. Numerous smaller lakes, however, many entirely too small to be shown on a map of this scale apparently have no drainage. Peat bogs are numerous, and sometimes extensive, both north and south of the moraine.

Swamps and Bogs

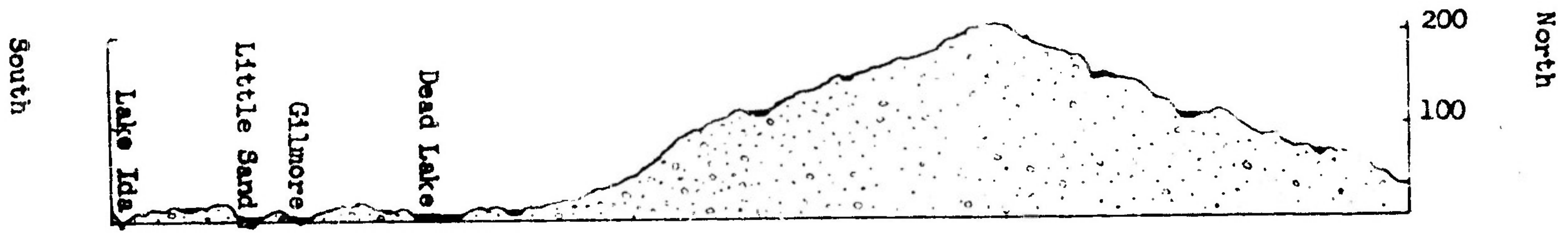
The Hubbard Area, being one of kame and kettle topography, has numerous small depressions which are in the process of being filled or have been filled recently. In the beginning these small depressions held

HUBBARD COUNTY AREA



Map 6

North-South Cross Section of Hubbard Area



Horizontal scale: 2 miles to inch
Vertical scale: 200 feet to inch

Numerous kettle lakes and bogs occur scattered over the moraine and outwash plain to the south.

Fig. 94

water but with increasing plant growth and sedimentation they have been either completely or partly filled forming swamps, marshes and bogs of various kinds.

> Undrained basins or depressions are characteristic of pitted outwash plains, roughened moraine and undulating till plains. When the bottom of such a basin becomes filled with sediments or plant deposits, it forms a flat area surrounded by a higher rim. This is the filled basin.*

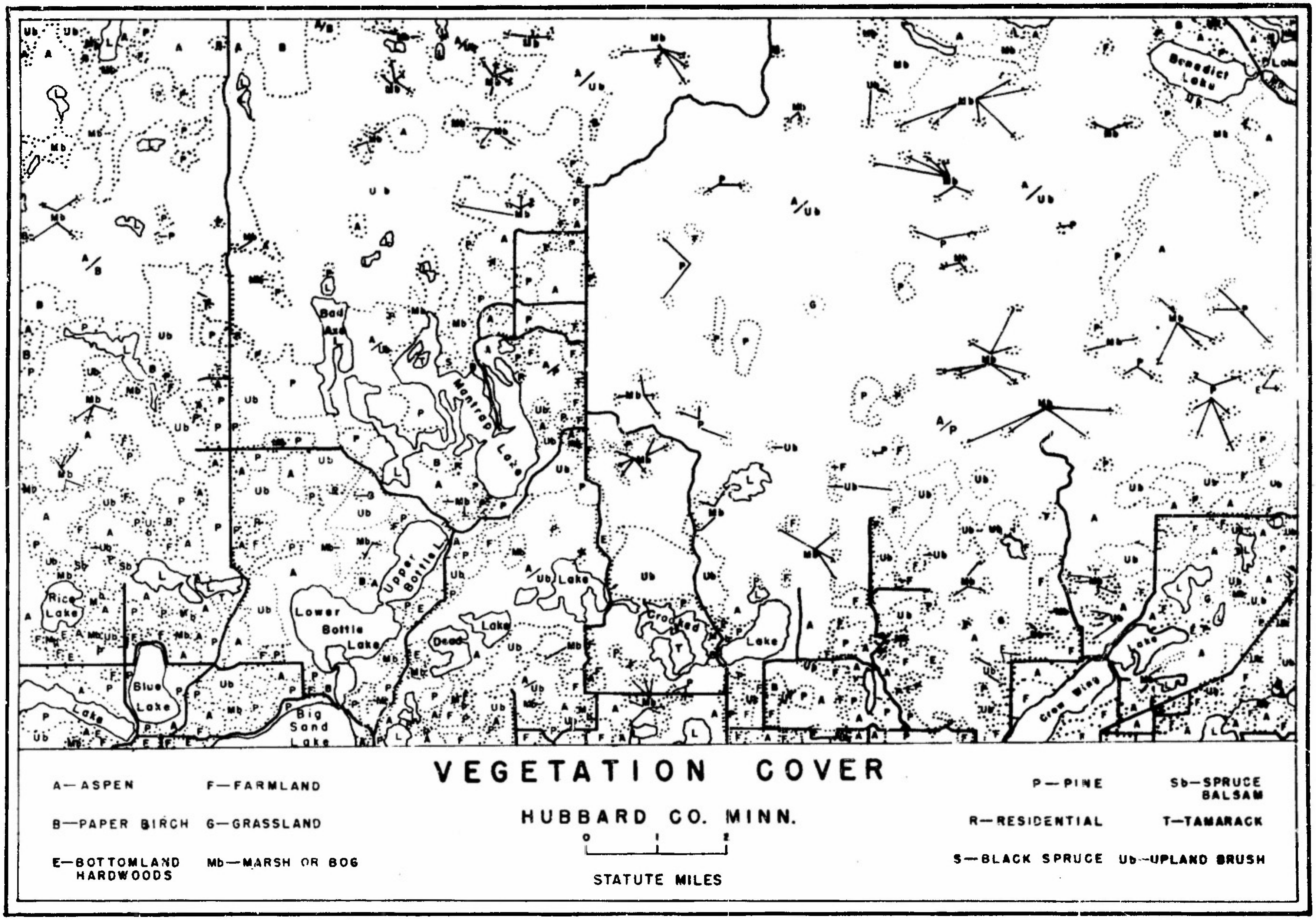
Swamp areas of varying sizes are found around the edges of numerous lakes. Floating bogs are a common feature of many of the larger lakes. In some of the smaller depressions where only the grasses and reeds formed, marshes are to be found (Fig. 96). In some cases muskeg has developed in these depressions. Frequently when the ground around the edges of the depressions is solid enough, farmers in the area will harvest the native grasses and use it as a feed crop. Examples of wild hay meadows are shown on Figures 102 and 103. These meadows occupy lowlands of kettles within the morainic area.

The marshes, bogs and swamps within the moraine do not present as many difficult problems as are presented by such features in the Koochiching or Itasca Areas. Their relatively small size generally is not a hindrance to cultural development.

Vegetation

Most of the moraine area was originally covered with coniferous forest, the prevailing trees being jack, white and Norway pine. Hardwoods mixed with Norway and white pine occupied most of the high ridges. Occasionally there was a scattering of oak among the pines. Around the

*Powers, _op. cit._, p. 11


VEGETATION COVER
HUBBARD CO. MINN.
A—ASPEN
B—PAPER BIRCH
E—BOTTOMLAND HARDWOODS
F—FARMLAND
G—GRASSLAND
Mb—MARSH OR BOG
P—PINE
R—RESIDENTIAL
S—BLACK SPRUCE
Sb—SPRUCE BALSAM
T—TAMARACK
Ub—UPLAND BRUSH
0 1 2
STATUTE MILES
Benedict Lake
Bad Axe
Mantrap Lake
Upper Bottle L.
Lower Bottle Lake
Dead Lake
Crooked Lake
Big Sand Lake
Blue Lake
Rice Lake
Crow Wing

Map 7

kettles and lakes, especially around the edges of the wetter parts, black spruce, tamarack and white cedar were common. Parts of the peat areas were also covered by poor to fair stands of black spruce and tamarack. The remainder of such areas was often covered with sedges or shrubs. In recent years since much of the pine has been harvested, aspen has come in rather profusely.

In the moraine area today aspen is the principal hardwood since it produces rapidly on much of the finer textured soils. Frequently jack pine occurs in poor stands, especially in the sandy soils following fires. It also occurs in mixture with other species on a wide range of sites. For the photo interpreter there is a problem of distinguishing jack pines from spruce stands in this particular type of area. The poorer jack pine stands most frequently occur in the bouldery, choppy topography. In general jack pine presents a thin crown character particularly when outlined in shadow (Fig. 101). Jack pines have a more rounded crown than do spruce, and photograph in a somewhat lighter tone.

Transportation

In general, transportation in a moraine area will not present great problems. The area is sandy with a few clayey spots. Road construction can be done from July to the middle of October. After the latter date it is impossible because of frost. Bogs in general are no problem but when they have to be crossed three methods are employed. In some cases the peat is dredged out, especially if it is a small bog, and the area is filled with sand from the adjacent hills. A second method of floating

the road across is done in some areas. Where the road is floated across, sand and other material is put on top of the peat until a degree of relative stability is achieved. This type of road, however, is unsatisfactory for heavy traffic, as dips and breaking are likely to occur. The third method used is to remove the vegetation and roots of the peaty plants and then put in a light fill. Materials for these fills are readily available throughout the area. Erosion is the main problem of road construction.

As shown on Figure 102, many roads do not follow straight lines. They curve around the bogs or swamps if at all possible, often following the sandy ridges. Where the principal highways have been built as indicated in Figure 70, many fills have been used to keep these roads in line. Railways especially have to make both high and low fills, as well as cuts through the sand ridges, in order to shorten the length of their lines.

Cultural Factors

In the moraine country there are no hamlets or villages of any size. Along the shores of the larger lakes some recreational resorts have been established. These, however, are largely a seasonal business and roads connecting the resorts with the principal highways are usually of a graded type, lightly gravelled.

Farm homes are more numerous along the edges of the moraine than in the central part. However, in some of the rougher areas more energetic farmers have tried to clear some of the more level land and put it into cultivation. The soils in the moraine are not conducive to good

agriculture, thus the fields are small and scattered and of very irregular shapes (Fig. 105). Farm homes in the terminal moraine belt are, for the most part, not to be compared with those on the clay moraine or the outwash gravel plains.

Conclusions

The swamps and bogs in a moraine area, such as that of Hubbard County, would not present difficult problems to the present day maneuvers of troops or vehicles unless the moraine happened to be the very front lines. Under such conditions as that the whole moraine would present a logistics problem. On the ridges during the summer and fall season, especially in areas of deciduous trees or in regions of thick stands of coniferous trees concealment from the air would be relatively easy. During the winter and spring seasons very little concealment would be possible outside of the swamps. The swamps in themselves could be used for storage areas and possibly bivouac areas after they have completely frozen. Certainly any light thaw would leave water standing on the surface. Food in such an area would have to be brought in, since settlement has driven out most of the native wild life. No native vegetation is of the food producing type suitable for human consumption.

Fig. MULTICOLORED

Fig. 95 - A view to the west along the crest of the Hubbard Area moraine from the top of the Mantrap Lookout Tower. This rugged feature is pock-marked with kettles. Some are filled with water while in others marshes have developed. Mixed stands of conifers and hardwoods, primarily Aspen, cover the slopes.

Fig. MULTICOLORED

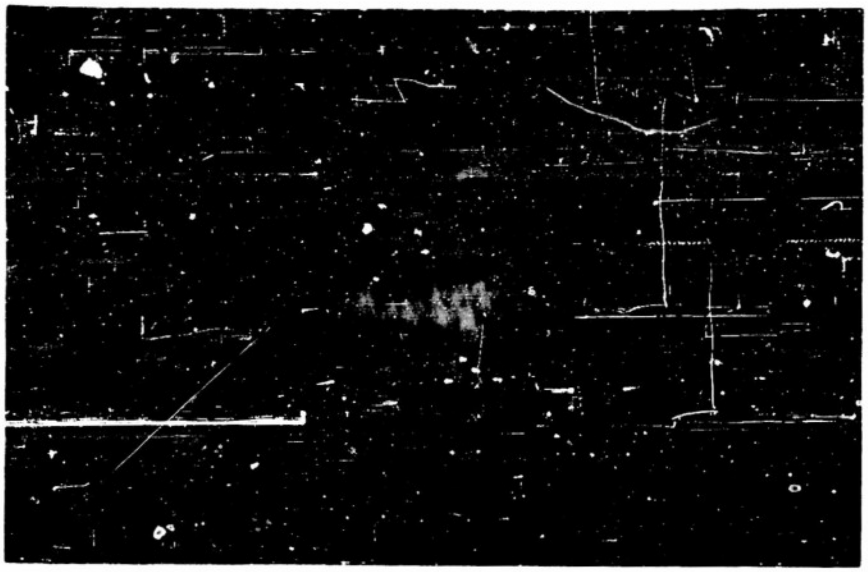


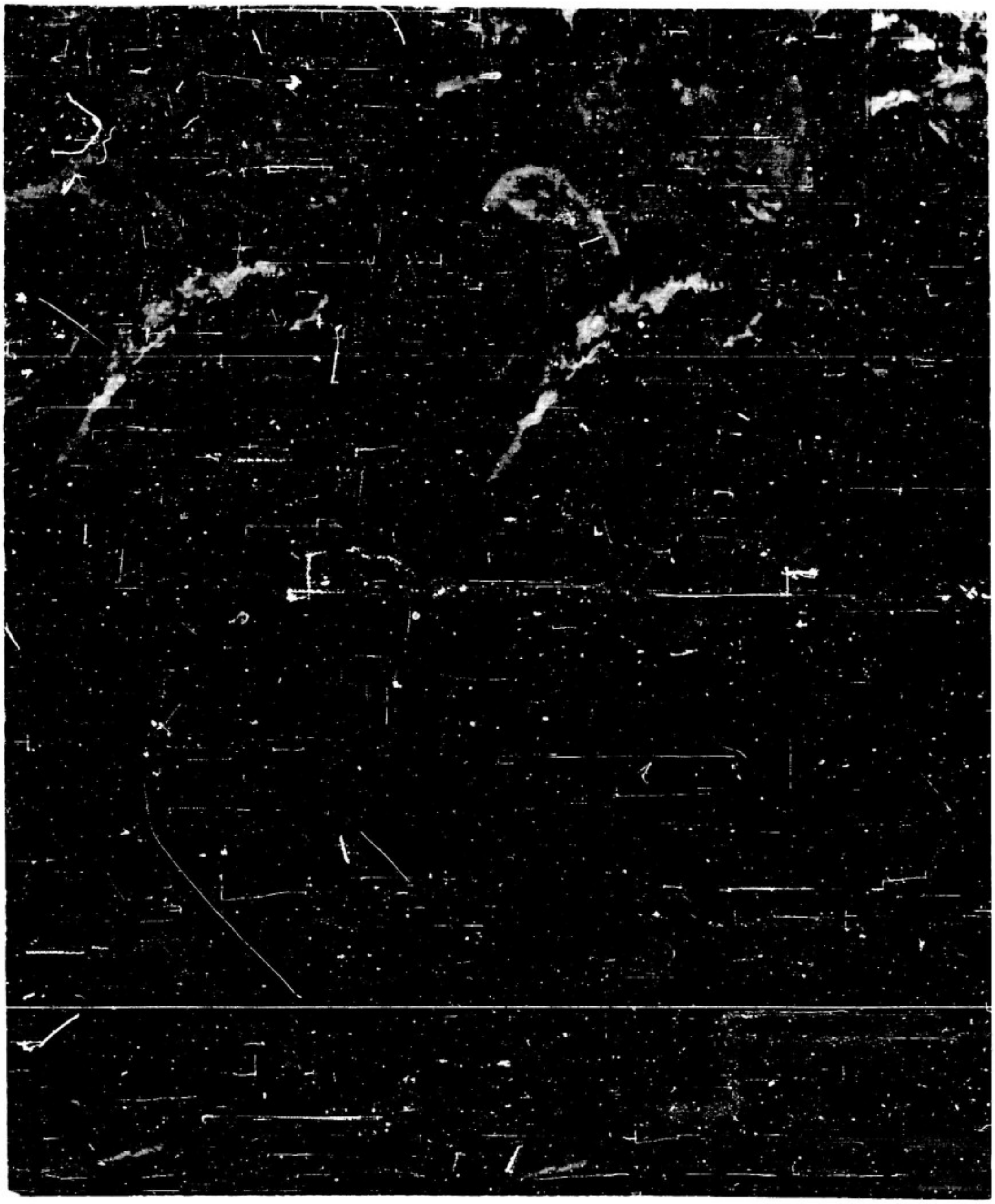
Fig. 96 - A small water and marsh filled kettle on the moraine in the Hubbard Area. Location is 5.7 miles south of Lake George. The lake and marsh margin is sharp as slopes descend precipitously into the kettle holes.

Fig MULTICOLORED

Fig. 97 - A small kettle lake on the southern slopes of the Hubbard county moraine. The lake is sufficiently deep except on the left margin (invisible on this photo) to discourage water plants that convert shallow lakes into peat bogs. Cut over land that is now used for pasture. View is southeastward from road. Three miles northeast of Mantrap Lake.

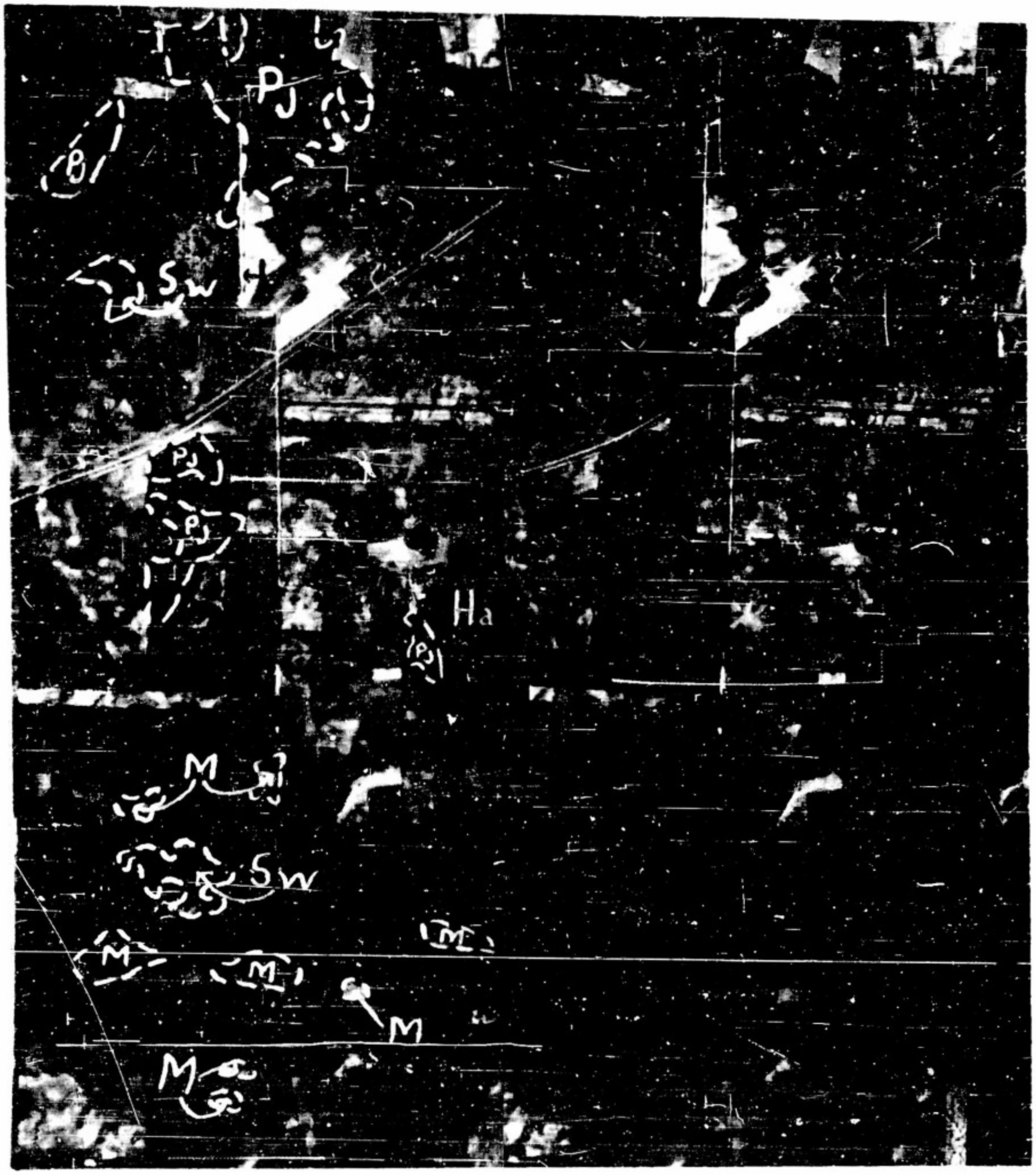
Fig. 98 - Looking toward Mantrap Lake on the terminal moraine in the Hubbard Area from the Mantrap Ranger Tower. The dark toned trees are conifers, primarily Pines, while the dominantly lighter toned trees are hardwoods, mainly Aspen. The very light tone in the background is the surface of the lake.

Fig. 99 - A kettle lake that is rapidly being filled. Many lily pads are floating on the surface. Good examples of Poplar are shown in the background.



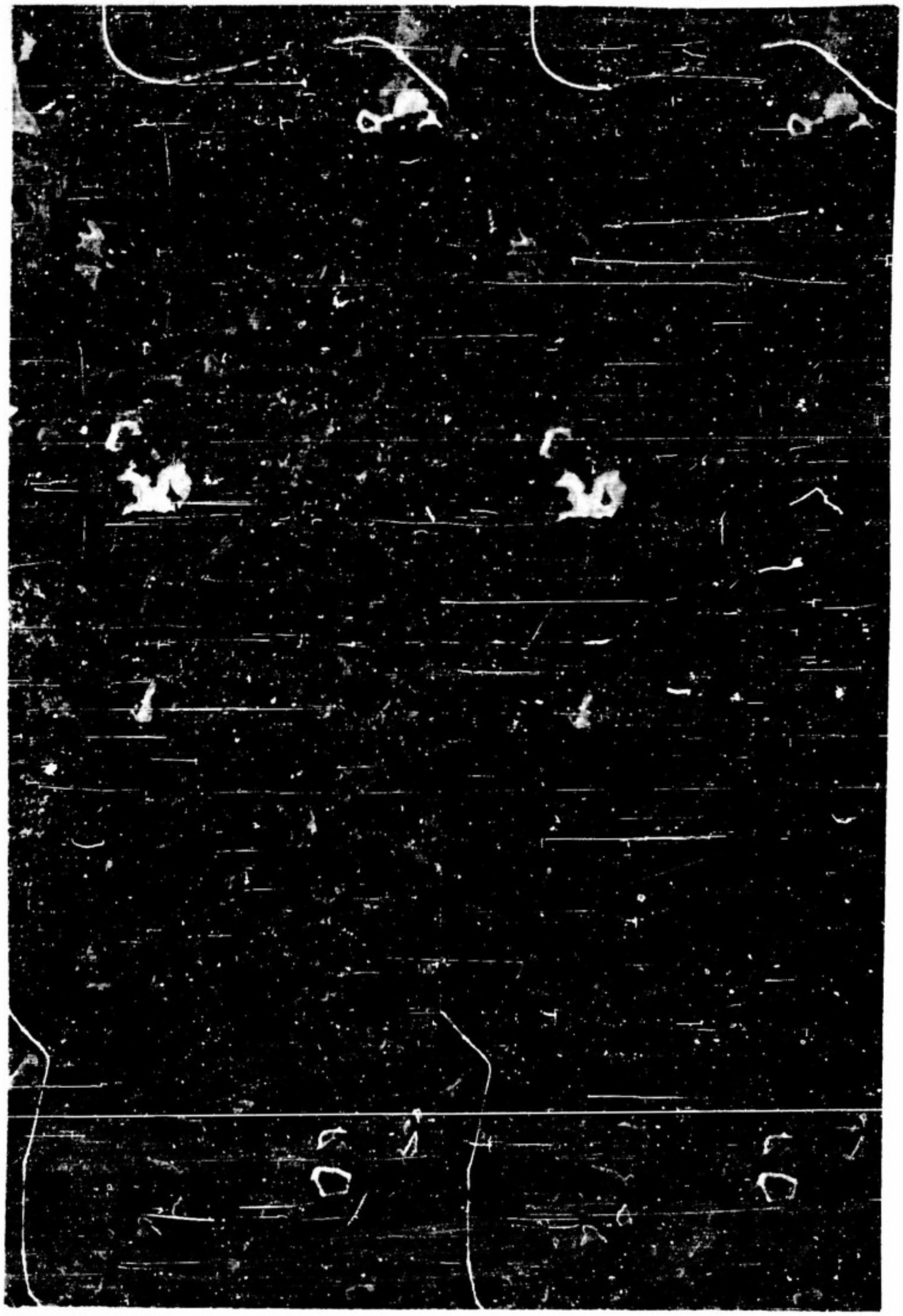
Scale 1:7,500

Fig. 100 - HUBBARD AREA. In moraine areas a variety of conditions are always apparent. The kettles, and larger depressions, that have water in them will be covered with snow and ice during the winter. Swamps (Sw) and floating bogs (FB) are shown by their variety of tone and texture as well as location. Coniferous trees as shown by Jack Pines (Pj) will be darker than the deciduous. In general the non-paved road (1) will have a lighter tone than the paved road (2). Railroads (3) are identified by the track lines. Fields (4) show the results of cultivation.



Scale 1:20,000

Fig. 101 - HUBBARD AREA. The numerous low places shown on the moraine are kettles. The bottoms are frequently covered with swamps (Sw) or marsh (M). In some cases the swamps will have floating bogs around the edges. Where the land has been cleared, attempts at cultivation are taking place. In general, roads (1) and railroads (2) follow straight lines, making fills or grades where necessary. In most cases the kettle swamps are too small to be considered a difficult engineering problem. Hardwoods, with Aspens dominant (Ha) and Jack Pines (Pj) form the principal type of vegetation cover. A portion of the above area during the winter season is shown on Figure 100.

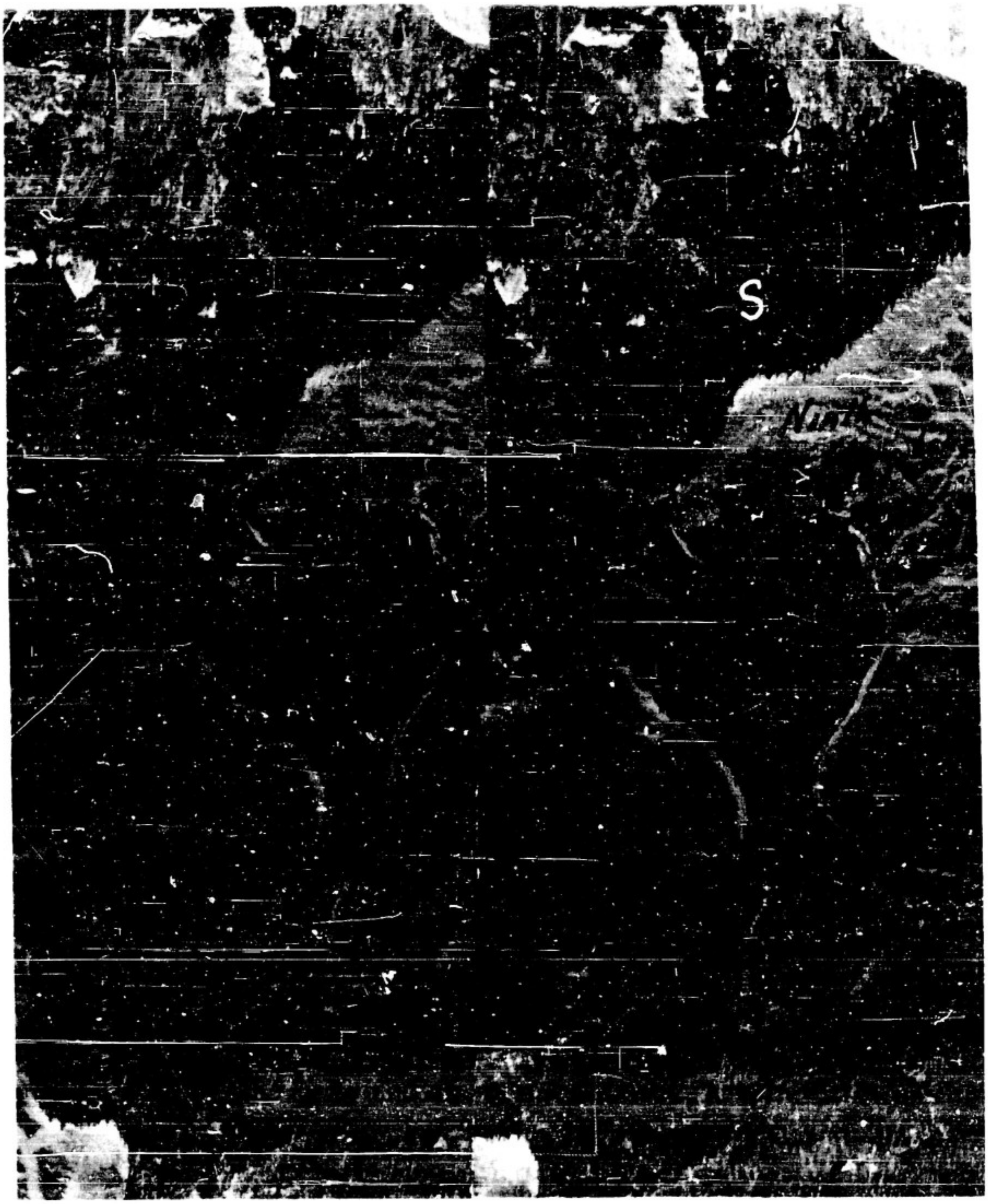


Scale 1:20,000

Fig. 102 - HUBBARD AREA. When the depressions are large enough and have filled beyond the floating bog stage, the grasses that grow in them will make good feed, and the farmers in the vicinity commonly identify these areas as wild hay meadows. In the wild hay meadow near the top of the photograph small white dots appear. These dots are the stacks of hay after it has been cut and raked. The irregular surface of this figure is quite typical of much of the terminal moraine surface. Numerous swamps (Sw) and marshes (Mse) as well as small lakes can be identified. The principal tree is Aspen (Ha).

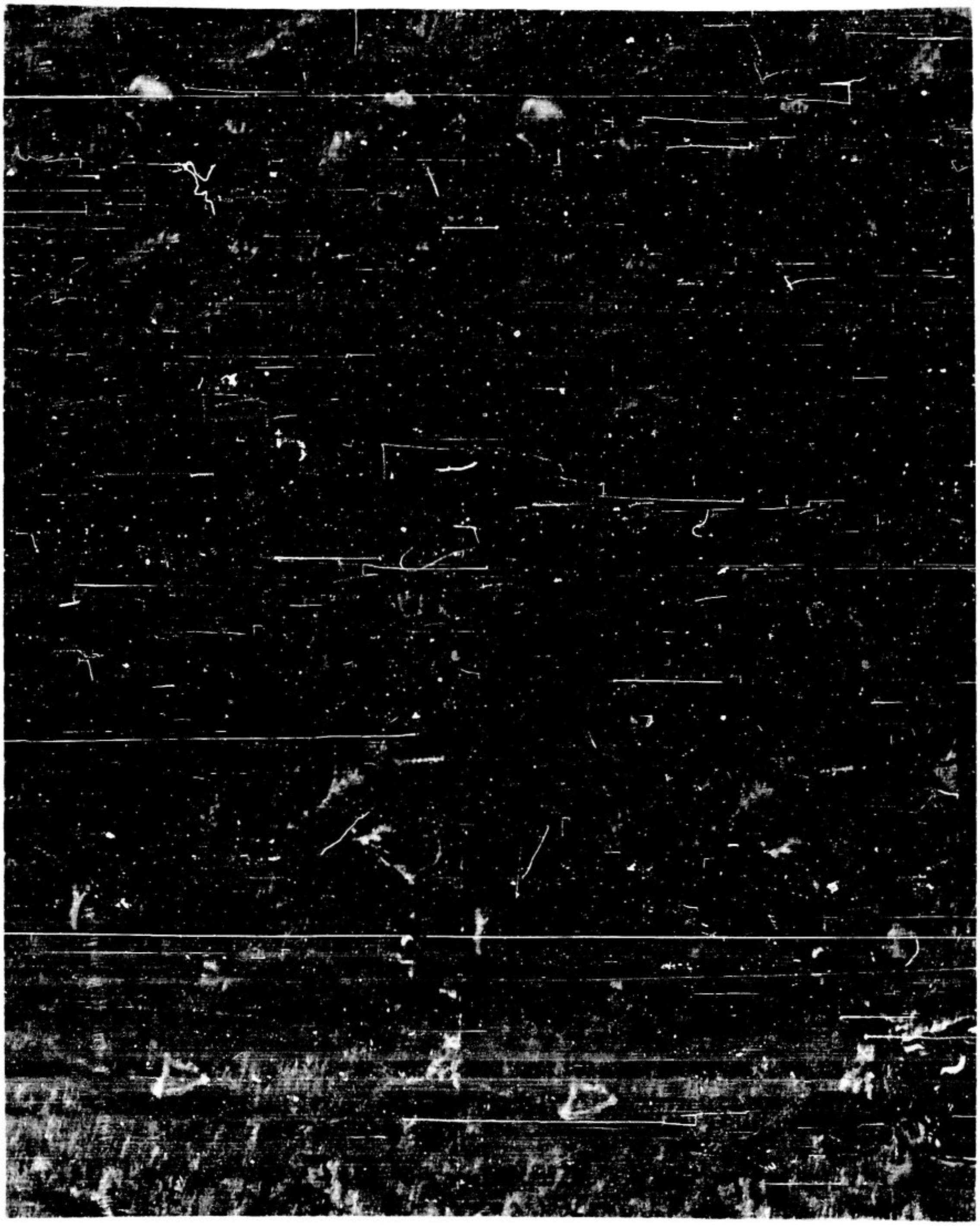
Scale 1:7,500

Fig. 103 - HUBBARD AREA. This winter stereo pair should be compared with Figure 102. The hardwoods, primarily Aspen (Ha), present a streaked appearance with few individual characteristics. The coniferous trees cast a definite shadow. The wild hay meadows vary from dark to light tones.



Scale 1:7,500

Fig. 104 - HUBBARD AREA. This winter photo shows clearly the difference in tone and texture between Spruce (S) and Aspen (Ha). Only rarely does the deciduous tree ever appear as dark as the coniferous. Since the short connecting river is darker than the ice covered lakes running water is indicated. The flowing water is considerably darker than the asphalt covered highways (1).



Scale 1:7,500

Fig. 105 - HUBBARD AREA. The overall light tone of this stereo pair is the result of a partly melted snow cover. Many of the steeper slopes are darker than the ridges or valleys due to lack of snow cover. Pines (P) are darker and cast more definite shadows than the hardwoods (Ha). The numerous small, rounded depressions are kettles.

Fig. 106 - Stand of Jack Pine located 10 miles south of Lake George in the moraine of the Hubbard Area.

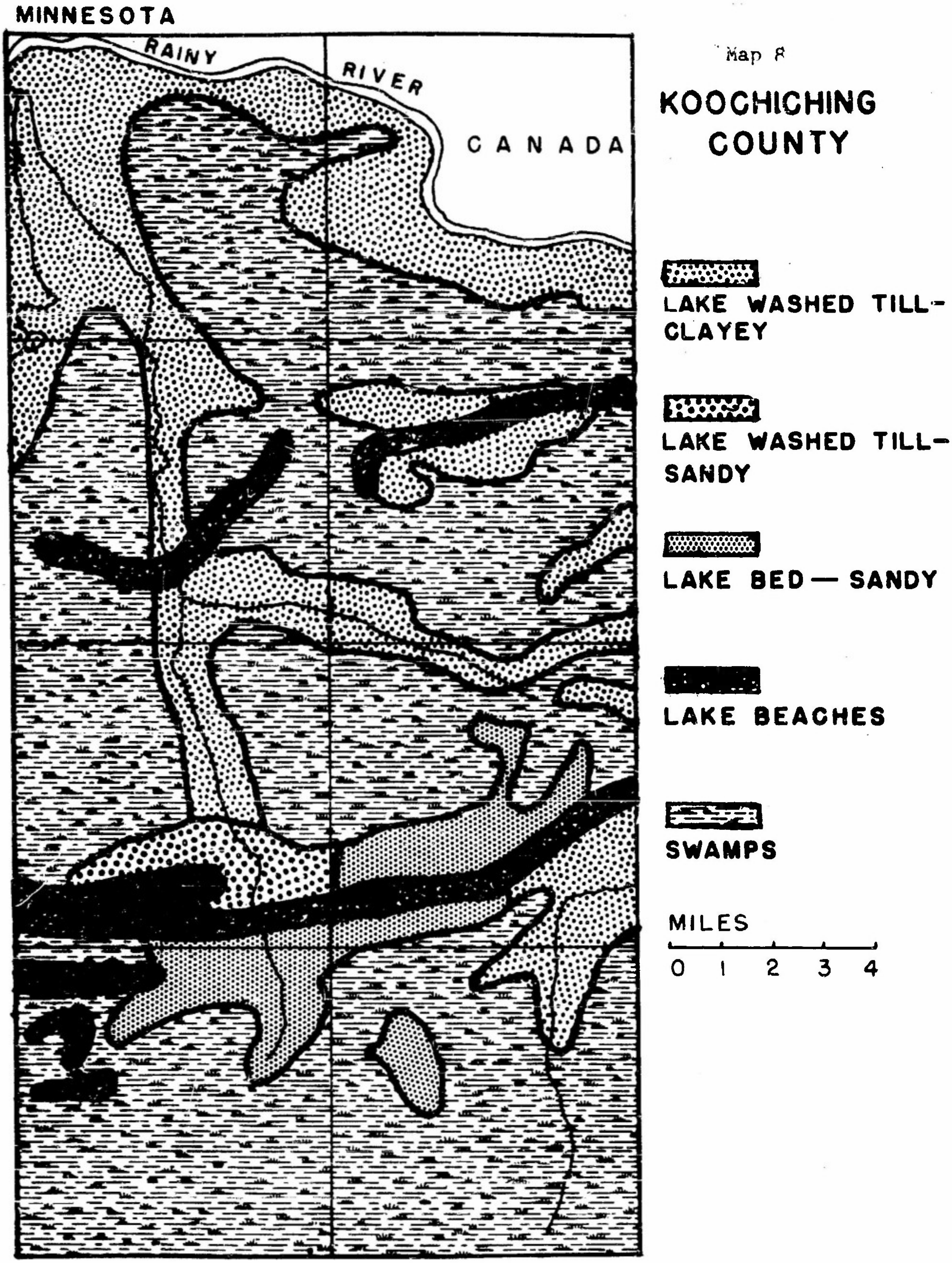
Fig. 107 - Stand of Aspen in the foreground with Jack Pine to the right. Located north of Park Rapids in the moraine area.

Chapter VIII

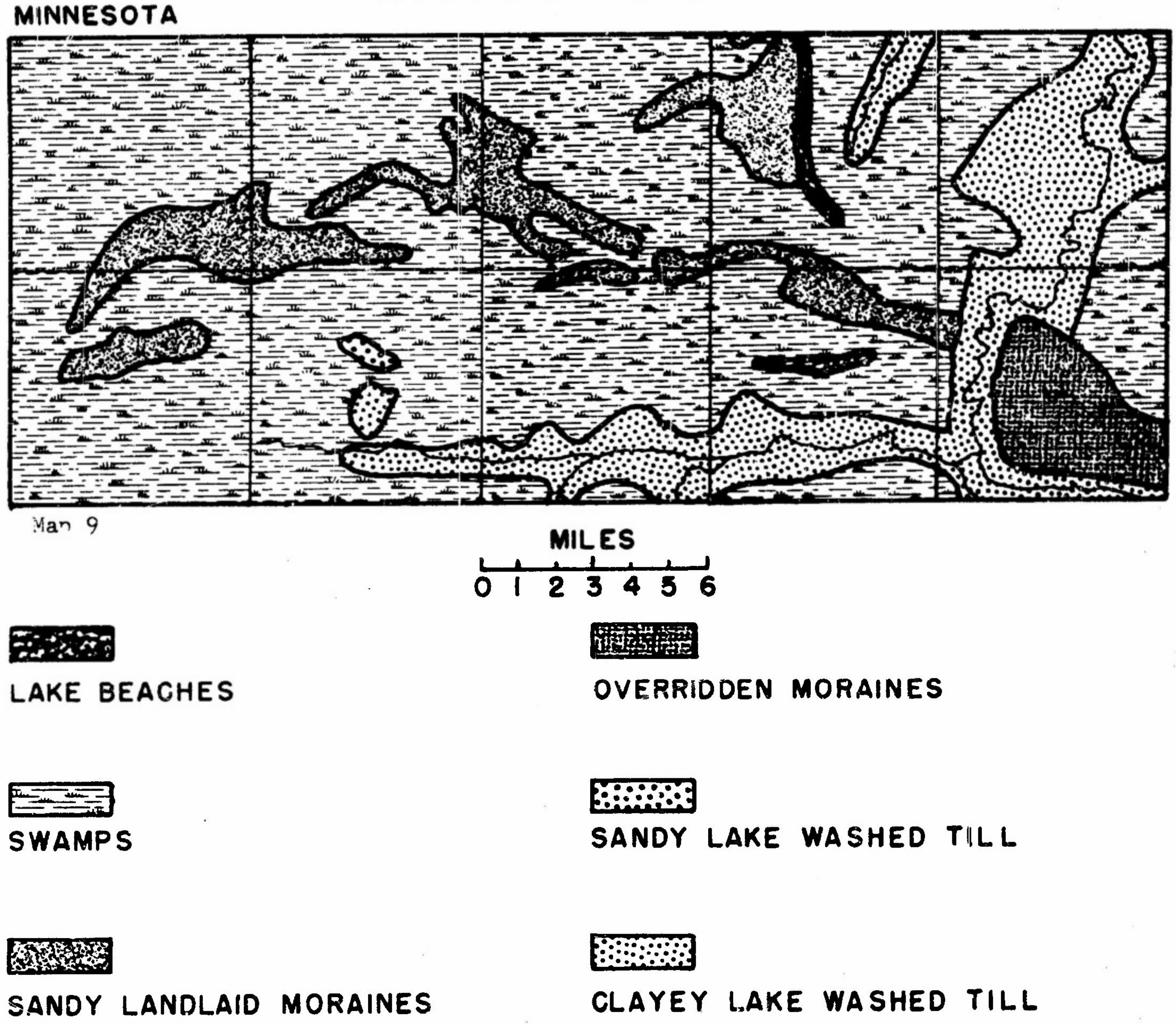
THE KOOCHICHING AREA

Traveling north along Minnesota Highway No. 72 near Red Lake one is confronted with a large sign which reads as follows: "Don't be discouraged by the next 35 miles. Paradise on the other end." When one reaches the so-called "other end" he is in a small, somewhat dilapidated looking county seat village. The courthouse is a two story wooden building much in need of paint. Several smaller adjacent structures house the overflowing county activities. The business district of this village occupies about a block on each side of the main street. The largest building is a three story hotel in which the fixtures date its occupancy as about 1910. The stores in general show the lack of any great activity within the area. This village is Baudette, the county seat of Lake of the Woods county, Minnesota. Even with this general decrepit appearance it does appear to be a "Paradise" after the thirty-five miles which have just been traversed.

The thirty-five miles of paved highway have been built through a part of the Beltrami swamp. Along this highway very little is to be seen except swamp vegetation in all of its varying sizes and shapes. During the flowering season of some of the small swamp plants a desolate type of beauty is viewed. During the spring season when the land is beginning to thaw, water, mud and muck, covered by dead reeds and brushes intermixed with stunted spruce and tamarack, form the principal part of the landscape. This area which extends over much of northwestern Minnesota is indeed the epitome of all glacial swamp regions


MINNESOTA
RAINY
RIVER
CANADA
Map 8
KOOCHICHING
COUNTY
LAKE WASHED TILL-CLAYEY
LAKE WASHED TILL-SANDY
LAKE BED — SANDY
LAKE BEACHES
SWAMPS
MILES
0 1 2 3 4

KOOCHICHING COUNTY



along the southern edge of the Boreal Forest area in the North American continent.

In order to study at least a part of this large swamp region in detail, the eastern end of the region, formerly covered by glacial Lake Agassiz, was selected. Since most of that region is now in Koochiching county, Minnesota, this particular area has been called the Koochiching Area.

Geology

Two generalized geology maps for selected parts of the Koochiching Area have been made (Maps 8 and 9). Both maps show that the area is primarily a region of swamps. Along the rivers in each, where there is a semblance of drainage, some of the water has been carried away and the lake washed till plains exposed to the surface. Across each of the areas are old lake beaches and/or sandy landlaid moraines. The moraines and beaches differ greatly from the rest of the area, not only in type of structural material but also in the vegetation on them. The large area covered by sandy moraines, Map 9, causes such a different appearance in the landscape that it is commonly spoken of as Pine Island.

Dr. Harry E. Hoy* has given the following interpretation of the formation of peat bogs and muskegs in the Koochiching Area:

> During the recession of the ice sheets the level of Lake Agassiz dropped by successive stages thereby leaving a series of beach lines at lowering levels. Extending across the area in a general east northeast-west southwest direction are a number of igneous sills or dikes which hinder northward or down gradient drainage.

*Dr. Harry E. Hoy, Professor of Geography, University of Oklahoma, Norman, Oklahoma

The swamps of Koochiching county in particular and the adjacent counties in general have been successively ice scoured, till sheet deposited, moraine filled and glaciolacustrine mantled. As Lake Agassiz drained away, the uneven glacial depressions on the bottom of the lake formed pockets, and a general undulating surface. Although to the casual observer it would seem flat had water not filled the depressions, leaving the higher places slightly above the shallow lake level. There were relatively few lakes deep enough to prevent the growth of hydrophytic plants from covering the surface, and upon their drying and freezing were submerged and preserved as peat. Originally these shallow water areas were extensive and slightly below the general level of the area, but as the peat deposits were built up and sphagnum moss, spruce and in some cases tamarack grew out of the peat, the accumulation of centuries of plant remains raised the level of these former depressions above the mineral soil areas surrounding them.

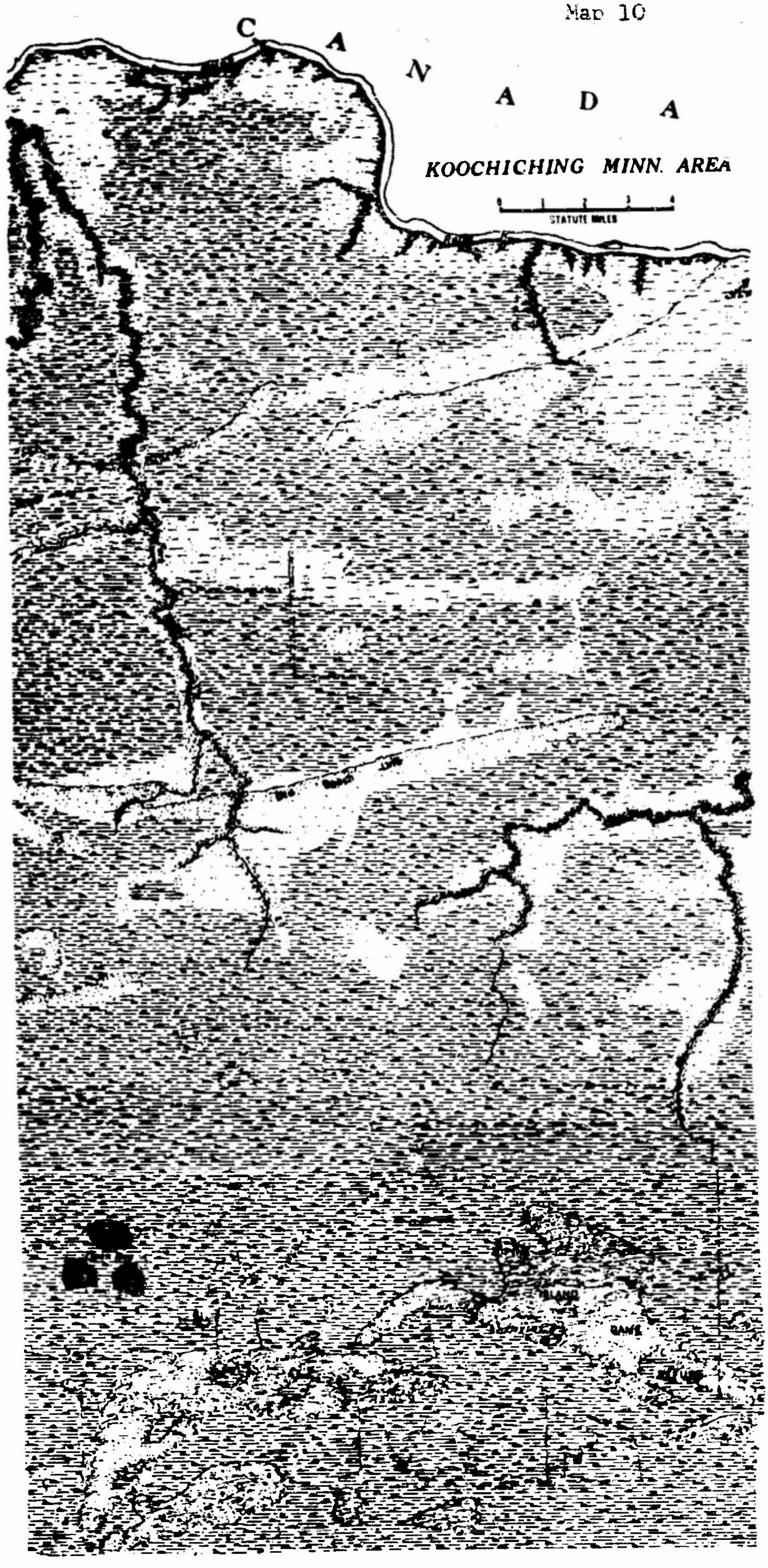
Today the anomalous situation exists where farmland adjacent to swamps is actually lower than the swamp and drainage from the fields cannot be toward but away from the swamp. The peat and sphagnum moss acts like a sponge or blotter and is capable of holding a water level above the field and even well above the bottom of ditches along or through the swamp. A typical case of such water holding action is that of a natural drainage ditch that has cut its way back from the East Fork of Rapid River near the Old Bridge. The water level in the river is approximately eight to ten feet below the muskeg to the southwest, a distance of approximately 200 yards. The ditch extends toward the swamp with sufficient gradient to readily drain the meadow through which it crosses, but it has not lowered the water level in the swamps to that of the meadow surface.

It is believed that the swamps are self perpetuating and that all of mans' efforts to drain them by ditching are doomed to failure. If the peat becomes drained by dry weather conditions or other means, fire is a real danger. Fires in peat bogs can only be extinguished by a rise in the water table. If the burning is complete the burned out peat leaves a clay pan surface at the old original shallow lake level which will again fill with water and start the cycle all over again.

Topography

The surface of the entire Koochiching Area is one of fairly low relief with very few breaks in the monotonous swamp landscape (Map 10). Scattered throughout the peat swamps are ridges or islands which emerge just a few feet above the surrounding bogs. The greatest elevation

Map 10



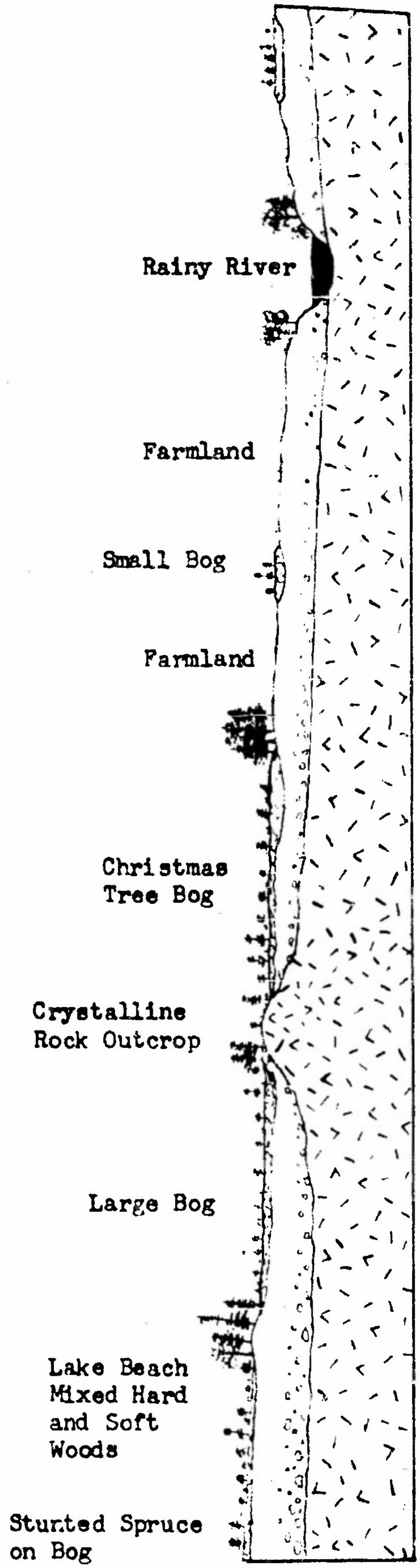


Fig. 108 North-south cross section along Minnesota Highway 72 in Lake of the Woods County. The crystalline bedrock is mantled by both glacial till and glacio-lacustrine materials. The stunted spruce have shallow root systems, mature trees of 75 years of age may have trunks no more than two inches in diameter. Sphagnum moss usually adds from six to twelve inches of growth to the surface of the peat producing a very spongy surface.

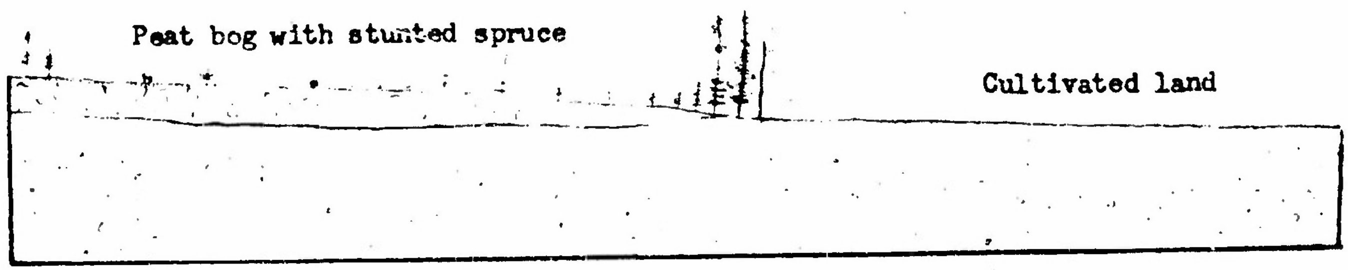


Fig. 109 Cross section illustrating typical bog and arable land relations in Northern Koochiching County, Minnesota. Note that the peat may vary from one to ten feet thick and rest on a mineral surface somewhat lower than the cultivated field to the right. The accumulation of organic material in the bog has raised its surface above the adjacent non-bog area. The blotter action of the peat prevents practical drainage of the bog but allows the water table to rise above the level of the field without water-logging the soil in the field.

north of Red Lake is about 1300 feet. This elevation represents the summit of Beltrami Island. Occasionally a large rock outcrop will appear.

Extensive marshes and bogs are scattered over the entire area. In some places, even on the divides between the drainage system, these bogs are held intact by the sand ridges and old beach lines on which good sized trees now grow. The old beaches and ridges are composed primarily of glacial drift. They were partly formed by marginal or recessional moraines as the ice front melted back, since they generally lie transverse to the direction of ice advances. Many of the old beach lines or shore lines were formed by Lake Agassiz during its receding stages.

Swamps and Vegetation

In regions such as that of the Koochiching Area, the swamps and their vegetation must necessarily be discussed under the same heading. The swamp produces its own peculiar type of vegetation and as has been stated above, the vegetation in turn perpetuates the swamp. The character of the vegetation in the swamp depends mainly upon the depth of the water. Where the water is more than five feet deep it is likely to be covered with what is commonly called muskeg. Muskeg is a thick growth of moss which fills and covers the water sufficiently to hide it, but yields to the foot so that one may sink to the knees or waist in water. Should one be unfortunate enough to step in a moose track or to break through the moss he will find it almost impossible to free himself.

Many of the muskegs show scatterings of grass, but cattails and

small tamaracks will be found growing in the firmer parts. In some places the muskeg surface is traversed with tamarack. Where the water is shallow, brush or smaller growth usually appears. Where the ground is relatively firm, it has a growth of scrub tamarack and some cranberry bogs. From this stage to the firm land covered with jack pine there is usually a succession of stagnant tamarack, full grown tamarack, spruce and/or cedar and pine. As in the Ely Area the cedar seems to prefer the pure waters of spring regions but the spruce will grow where the water is less pure. Where the swamp is connected with a stream and there is much decomposed material, willow brushes and alder grow quickly. When the depth of the water increases, tamarack may be killed out. In some instances on the drier land, cedars and spruce will replace tamarack.

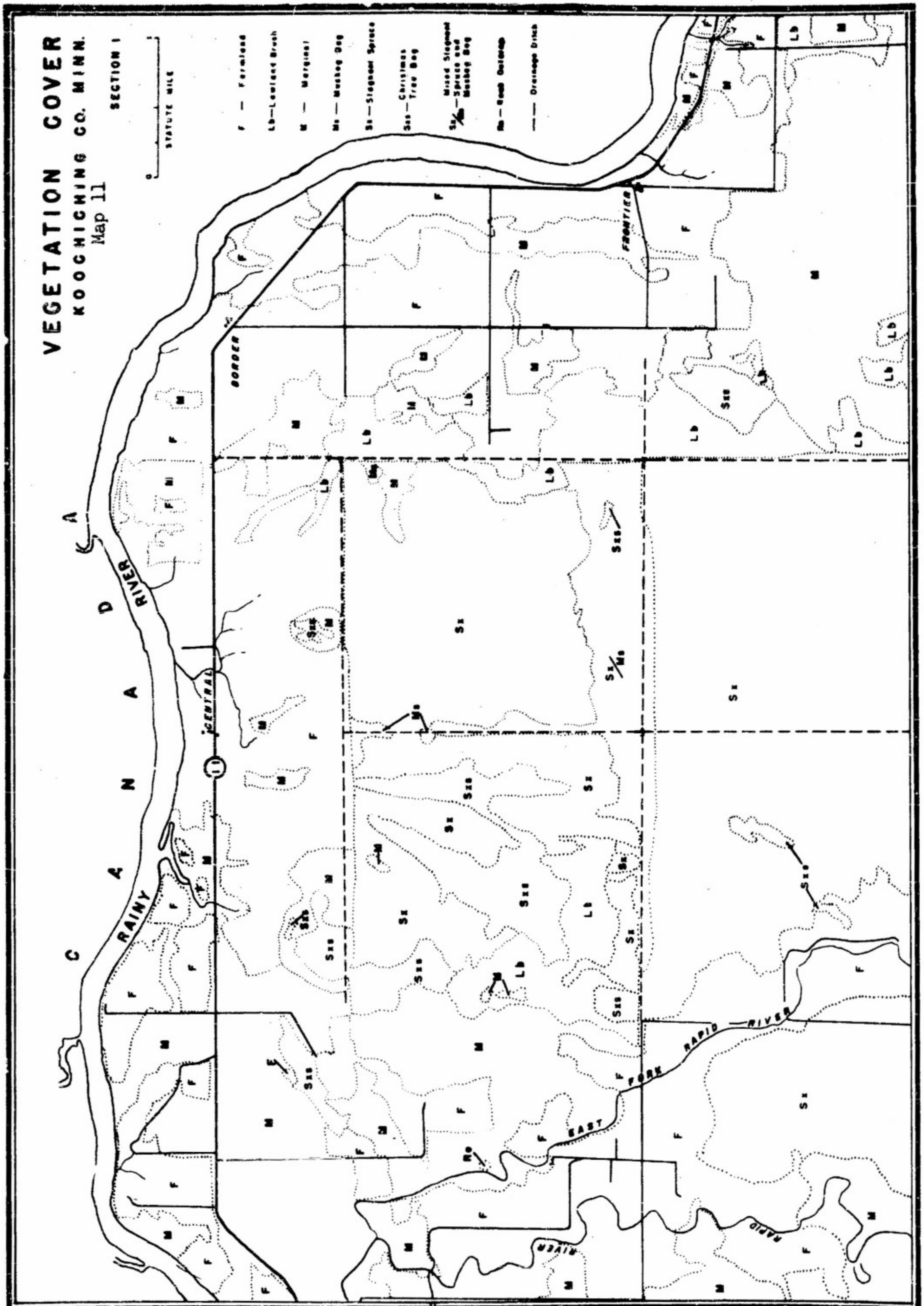
Plants growing in such a changing environment develop in about the following way. As a lake grows smaller in area the vegetation progressively encroaches on the lake margin. The first plants to survive the new environment are the pioneers. They must make adaptions which permit them to grow under extreme conditions. In general the effect of pioneer vegetation on a new area improves the general conditions for plant growth, since the plants less tolerant of excessive moisture than the pioneers may eventually develop in an area that was originally too wet for their survival. A succession of this type is called a hydrarch succession. At each successive stage of the hydrarch an invasion of the next zone in a lakeward direction takes place. The dead remains of the various zones will form a stratified record of the

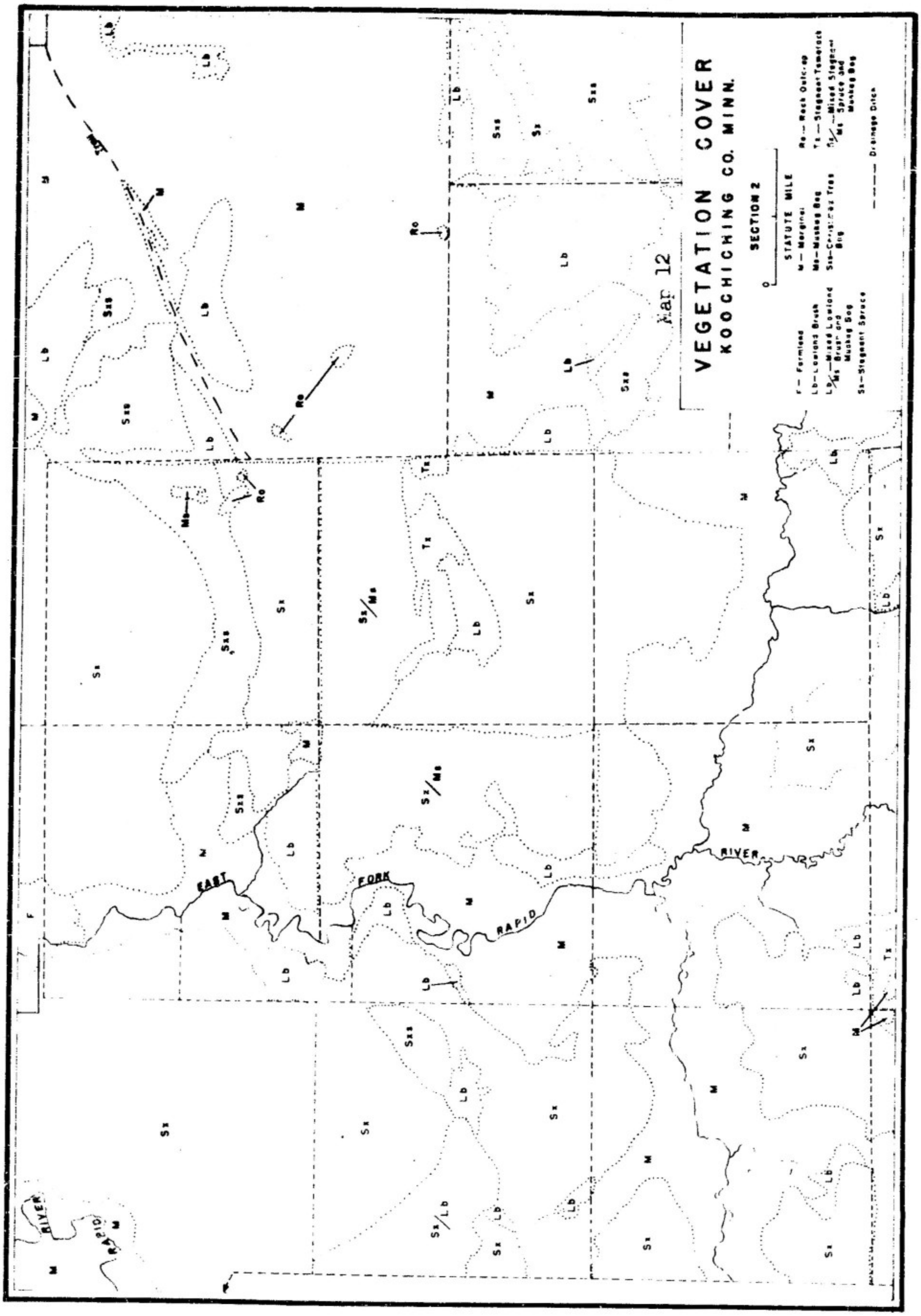
succession. The final result is one of layers of sequent plant remains with the pioneers on the bottom and the present plants at the top.

The hydrarch succession is important in the matter of permanent lake extinction since it represents the final phases in the filling of the basin. The rate at which this succession takes place in a given area, or climatic zone, is dependent upon many factors. For example, a temporary rise or fall in the water level will retard or accelerate the rate of advance but regardless the end product will be lake extinction.

A bog succession differs from the normal hydrarch in that the latter stage of the bog sequence is characterized by the bridging of all open water. This is brought about by the development of a floating sedge mat which grows lakeward from the edge of the bog. The various sedges which compose the mat extend outward each year as new roots grow. When the floating mat covers an open body of water it is known as a quaking bog. When the mat gets to be about two feet thick it can support the weight of a man. In the Koochiching Area the pioneer sedge mat is succeeded by trees such as black spruce, tamarack, and white cedar, which in turn are followed by the final stage of succession, the swamp hardwoods.

Maps 11 and 12 illustrate the general vegetation cover in the northern part of the Koochiching Area which is covered by Map 8. As will be noted, stagnant spruce occupies much of the area shown on these two maps. Muskeg bogs and Christmas tree bogs are also prevalent. In Map


VEGETATION COVER
KOOCHICHING CO. MINN.
Map 11
SECTION I
0
1
STATUTE MILE
F — Farmland
LB—Lowland Brush
M — Marginal
Mb — Muskeg Bog
Sx —Stagnant Spruce
Sxs —Christmas Tree Bog
Sx/Mb —Mixed Stagnant Spruce and Muskeg Bog
Ro —Rock Outcrop
—— Drainage Ditch
C A N A D A
RAINY RIVER
CENTRAL
BORDER
FRONTIER
11
EAST FORK RAPID RIVER
RAPID RIVER


Map 12
VEGETATION COVER
KOOCHICHING CO. MINN.
SECTION 2
0
STATUTE MILE
F — Farmland
Lb — Lowland Brush
Lb/Ms — Mixed Lowland Brush and Muskeg Bog
Sx — Stagnant Spruce
M — Marginal
Ms — Muskeg Bog
Re — Rock Outcrop
Tx — Stagnant Tamarack
Sx/Ms — Mixed Stagnant Spruce and Muskeg Bog
Drainage Ditch
EAST FORK RAPID RIVER
RIVER
RAPID

12 even the land along the East Fork of Rapid River is classed as marginal. Suitable farm land is located only in the better drained areas between the East Fork of Rapid River and Rapid River, or in the area approaching Rainy River as shown on Map 11. Black spruce, white spruce, cedar and tamarack form approximately 95 per cent of the vegetation cover in the wet parts. In the Pine Island area, which is sandy and considerably drier than the swamp region itself, various species of pine have developed. In some places where drainage ditches have been dug, the dirt thrown up along the sides of the ditches is drier than that of the surrounding areas. In such cases this drier ridge often has aspen growing upon it.

For photo identification purposes, black spruce is the characteristic tree of muskegs and other low lying poorly drained sites in areas similar to Koochiching. On aerial photographs it may be recognized by its characteristic very dark tone, its long tapering conical crown and the usual irregular open cover of its stands. White spruce has the same general range as black spruce, however, it is usually found on the better drained sites such as ridges and slopes. In general on aerial photographs its appearance resembles black spruce. White spruce will, however, probably have a fuller crown and photograph in a lighter tone. On infra-red photos its tone is considerably lighter than that of the black spruce. The greatest difficulty to the photo interpreter will be distinguishing between cedar and black spruce since the cedar photographs in dark tones especially on infra-red. The cedar, however, does have a more rounded crown than the spruce. Tamarack is easily

distinguished on aerial photographs by its feathery appearance and its lighter tones. During the winter it is distinguishable because it loses its foliage.

Transportation

Transportation in any part of a swamp is particularly difficult. The building of roads is an expensive and long range project since they can be constructed only during the summer season. During the winter season the use of the open swamps as highways is not recommended until they are completely frozen. Many accounts have been written about early exploration in the swamps and bogs of the Koochiching Area. An early attempt at exploration, under governmental direction, was made in 1908. The report included the following:*

> During the exploration of the swamps and bogs, pack horses were used where it was possible to get them through. Very often all necessary supplies had to be transported by the men themselves. Even with the outfit reduced to the smallest possible bulk, this was a very slow and laborius task, especially as level lines were carried on all pack trails. Camp was usually made wherever the close of day found the party and sometimes there was no available dry land on which to camp. Corduroy beds were often made from the dead tamarack. To these hardships were added the annoyance of swarms of mosquitoes and bulldog flies which made necessary the use of gloves, coats and head nets as well as a canopy of netting in the very hottest weather. It was impossible to get more than 20 miles away from the base of supplies when the transportation had to be done on men's backs.
>
> The early freezing of the swamps, with little snow on the ground, made it possible to use horses and sleds for transportation. In this way levels were carried along much faster and with more comfort than in the summer time. This work was continued until the middle of February when the snow became too deep for work and transportation.

*Drainage Survey of Certain Lands in Minnesota, House Document 27, 61st Congress, 1st session

The engineers in the area do not agree as to whether or not perma-frost is found in the Koochiching swamps. Mr. Hayes* stated that perma-frost was found in some of the bogs southwest of Loman late in June, 1953. It is entirely possible that what Mr. Hayes called perma-frost is only a temporary condition. He ran into this situation while clearing an area for REA lines. Other engineers, however, doubt that perma-frost is present. Mr Farrel** stated that fairly deep frost may remain in some of the bogs for most of the summer due to their insulating powers but he doubted that the frost would remain through the entire summer. In certain summers following an unusually cold winter, should the summer temperatures not reach the average, perhaps frost would remain in the ground during that particular summer. However, it would be the unusual rather than the general situation.

Should frost be found in the bogs during the summer when highways are being constructed, it would make their construction considerably more difficult if not impossible during that period of time. As explained in the chapter dealing with transportation, the methods of building highways must be carried on in the summer since for the construction of the best highways the peat must be removed. This would involve extra difficulties if the ground were frozen.

Although some of the principal highways in the area at the present time have been constructed along the water courses, it is generally agreed that these are poor site selections for permanent highways. The freezing and thawing that takes place each year may cause land slides which can, and often do, destroy parts of the highway (Fig. 59).

*Mr. H. Hays, Engineer for the REA, Warroad, Minnesota
**Mr. G. Farrel, Manager, REA Co-op, Spooner, Minnesota

The longest highways in this area have been floated over the deepest part of the bogs. Although large trucks travel on them it is doubtful that they could stand up under continuous usage where heavy tonnage is involved. Standing on the road shoulder one can note the trembling of the earth as a car passes by. The shoulders are often spongy even though they have been built up six to ten feet above the bog level. Driving onto the shoulder with a modern car is a risky proposition since the weight of the car, within a few minutes, would cause the car to sink deep enough for it to be stuck.

Cultural Factors

The principal cultural factor in the Koochiching Area is what is locally referred to as the "ditch folly." In the early part of this century various individuals, with the aid of the Government, concluded that the swamps of Koochiching and Beltrami counties could be drained. As a result, a series of drainage ditches six feet in depth were dug through much of the area. These ditches were dug in lines extending east and west and north and south crossing each other at two-mile intervals. In flying over the area, or in the examination of aerial photographs, these features are very noticeable. The drainage project was never successful for reasons stated in previous parts of this chapter. As a result the county was left heavily in debt. Although the entire project was abandoned about 35 years ago, the people are still paying off the bonds voted to carry on the ditching work. Since abandonment, many of the ditches have become partially filled. Beavers have come into the area and built many dams, thus blocking some of the ditches.

It is now generally agreed that all artificial drainage from the area should be stopped since the lowering of the water table increased the fire hazard. When first viewed on aerial photographs the ditches may give the impression that they are highways or roads because of their right angle crossings. Once under stereo, however, the depths can be noted. If water is standing within the ditches they frequently show as black on the photos. Aspen is found along the ditches where the dirt taken from them is higher in mineral matter. In areas of beaver dams, the raising of the water level, even two or three inches, has been enough to kill out the black spruce over large areas.

Settlements are found only around the edges of the Koochiching Area.. During WPA days an attempt was made to establish a small settlement within the swamp itself with the hope that some of the land could be farmed. A tamarack corduroy road was built to this settlement. Eventually the road burned and the settlement was abandoned. Farm homes, like those in other areas being studied, vary from very poor to excellent depending upon the fertility of the soil and the ability of the farmer.

<u>Conclusions</u>

The movement of troops or supplies in or through a swamp region such as that existing in the Koochiching Area is to be avoided if at all possible. If not, utmost care must be taken. Large trucks or heavy equipment can sink into the ground to such a depth, within a short period of time, that they have to be abandoned. Highway constructing firms often stated that they had lost a tractor or some other

piece of heavy equipment by parking it on what they considered solid ground for the night, only to return the next morning and find it almost entirely covered by muck and mud. A swamp area such as this, however could supply more natural food than the regions of smaller swamps, due to the large number of wild animals living therein. According to one of the local trappers it is almost impossible, however, to get close enough to the wild animals during the summer season to kill them. When these men hunt during the time that the swamp is not frozen they wear wide skis to keep them from sinking into the bogs. One man stated that he had gone into the swamps with parties of 12 men during the summer season, all of them walking on skis. He stated that each got through without too much difficulty.

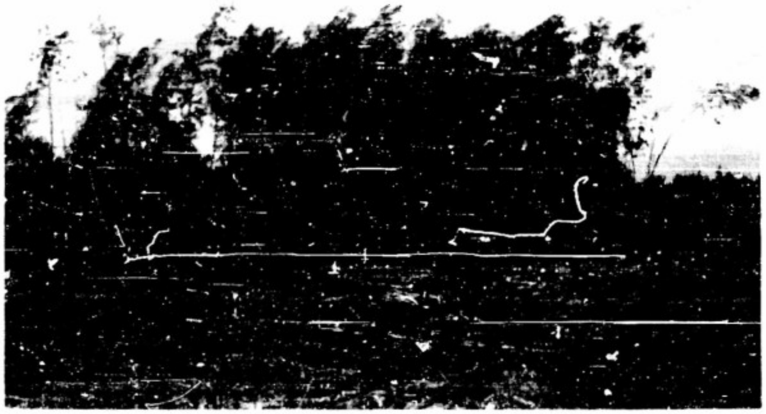


Fig. 110 - An area through which a peat fire has burned. After the burning was completed the surface fell in. During the rainy season a small shallow lake was formed. Such lakes preserve the material that falls into them and thus the start of another peat deposit is in process.

Fig. 111 - A close-up view of where the fire burned under one of the trees shown in Figure 110.

Fig. MULTICOLORED

Fig. 112 - A large rock outcrop in the Koochiching swamp area. Relatively dry ground is on all sides of the outcrop, since it is surrounded by one of the old gravel beaches that was formed by Lake Agassiz.

Fig. 113 - Another rock outcrop in the Koochiching Area. Like the outcrop in Figure 112, this one also appears in a beach area.

Scale 1:20,000

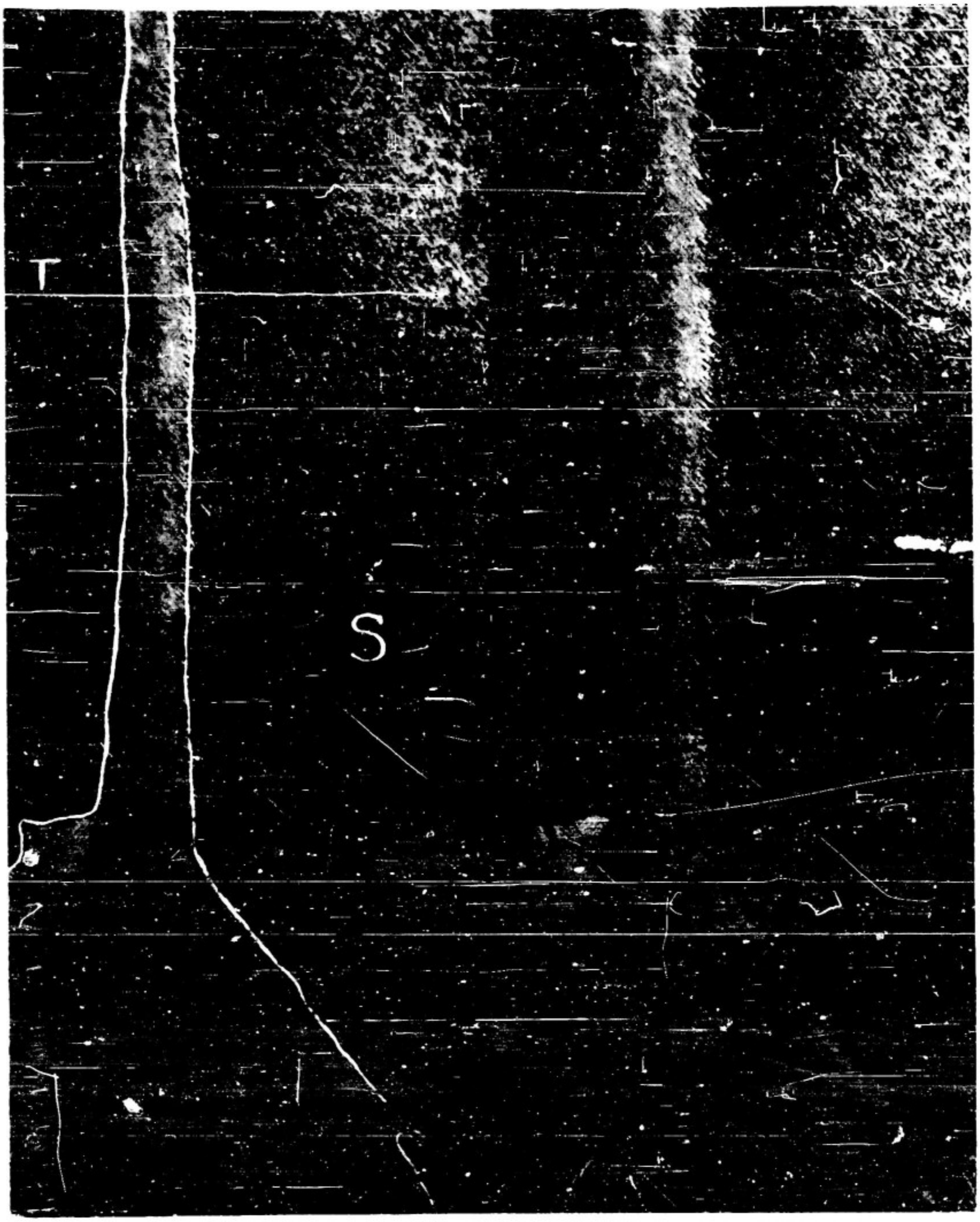
Fig. 114 - KOOCHICHING AREA. This stereo pair represents a rather typical and ideal vegetation transition toward the center of bog or swamp basin. Note the change from Black Spruce (S) or Spruce-Tamarack (S/T) to Christmas tree bog (Sxs) to stagnant Spruce (Sx) and stagnant Tamarack (Tx) mixtures to muskeg (Mk). Some Aspen (A) and White Spruce-Balsam Fir (SB) occupy drier areas.

Scale 1:7,500

Fig. 115 - KOOCHICHING AREA. On winter photos, drainage ditches (1) with trees growing along side may give the impression of rural roads. In stereo the ditches are ~~easily~~ identified by their depth. In some cases obstructions, possibly beaver dams, block the ditches. Aspen (A) often grows along the higher land beside the ditch since it is drier than the surrounding area. Stagnant Spruce (Sx) will indicate the general condition of the area.

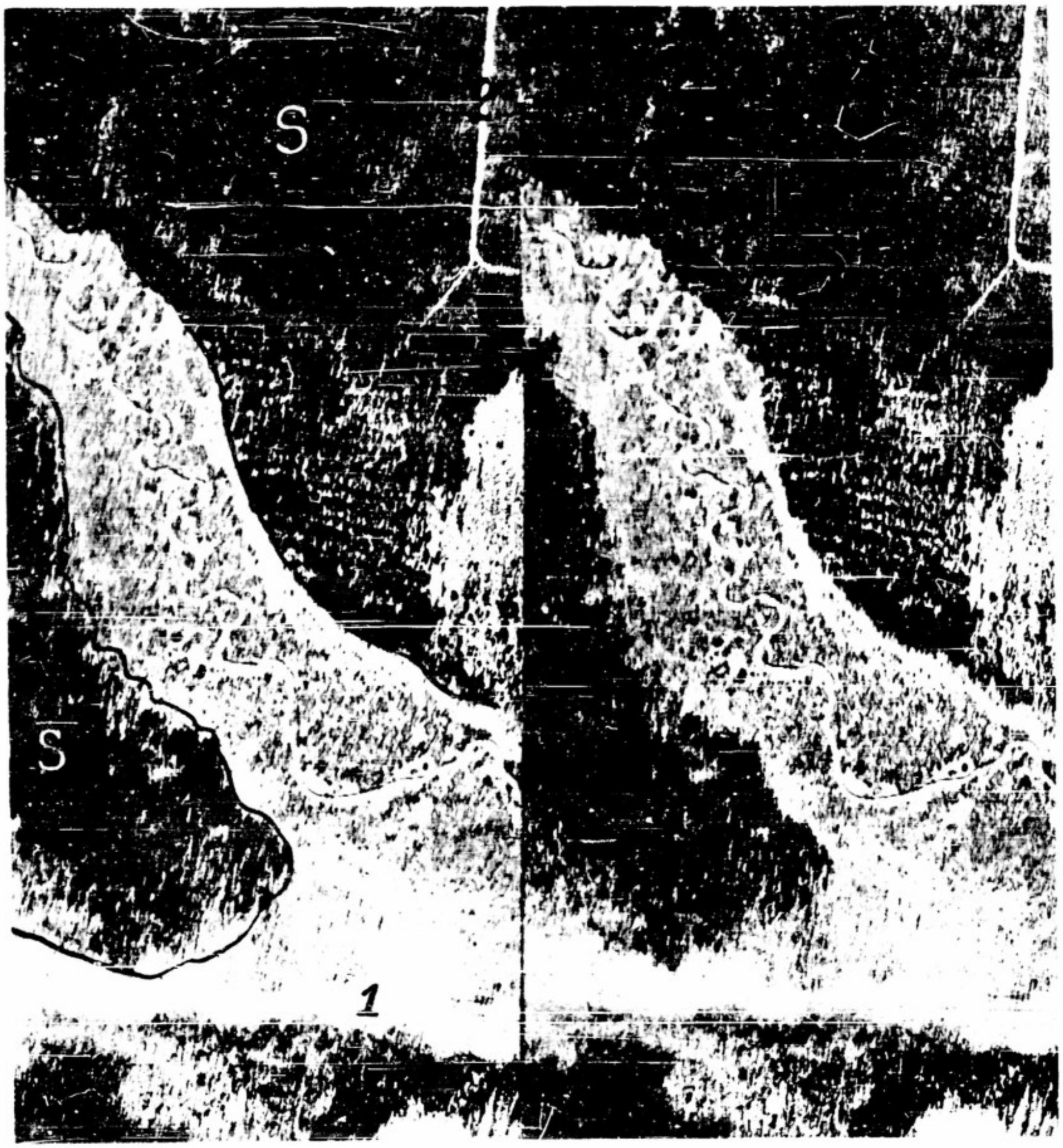
Scale 1:7,500

Fig. 116 - KOOCHICHING AREA. In areas of former glacial lakes old beach lines and gravel deposits stand out (3). In the lower part of the photo that has been cut off the deposit was definitely visible. Along the beach, or deposit, the vegetation always differs from that along either side. Such deposits form the best paths to follow when crossing swamp areas. Some well developed trails (2) indicate summer as well as winter usage. Naturally during the winter the trails will vary from the beach or deposit more than they would in summer since the more moist areas, as indicated by the stagnant Spruce (Sx), are frozen. A drainage ditch (1) crosses the area. See also Figure 117.



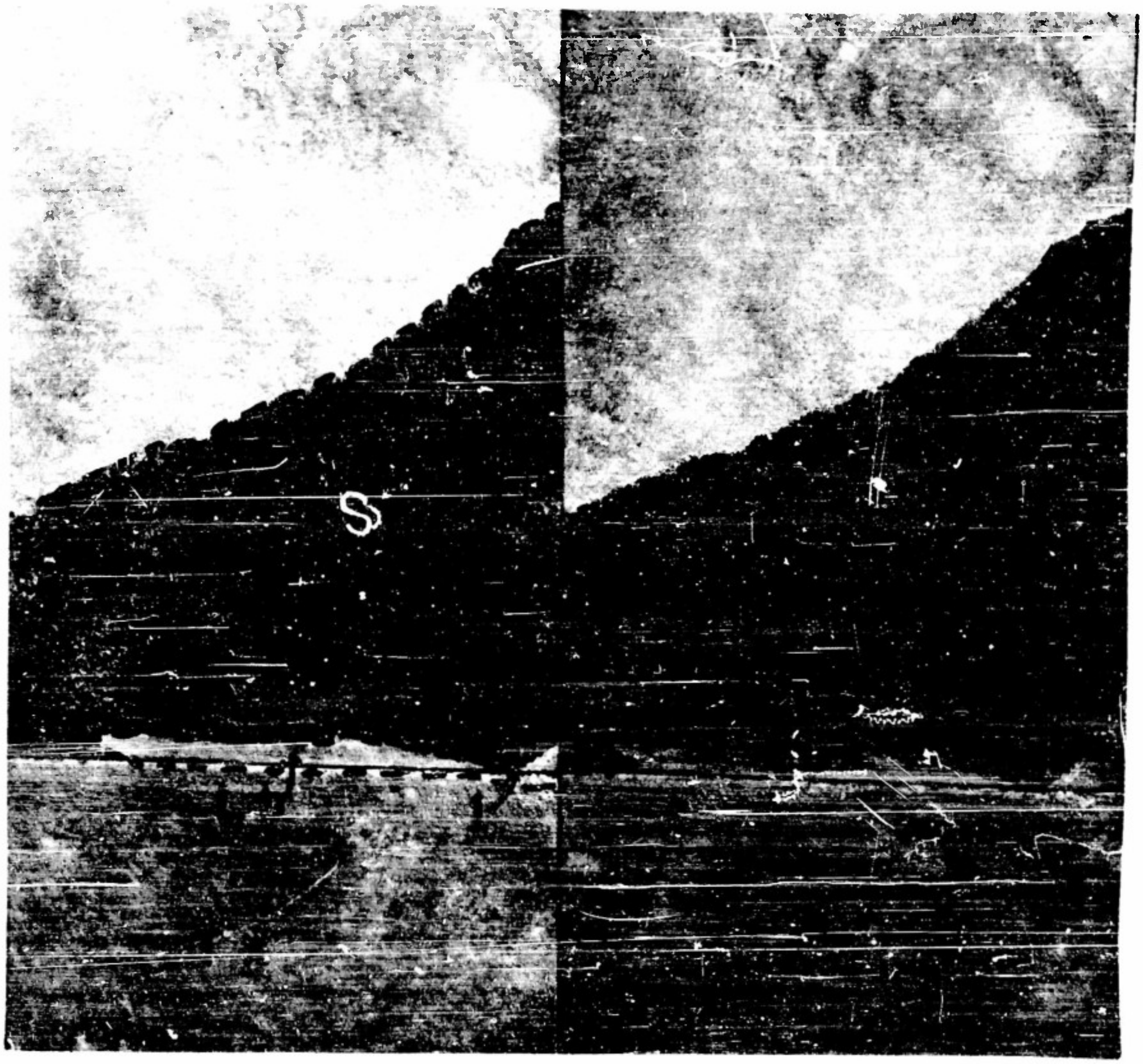
Scale 1:7,500

Fig. 117 - KOOCHICHING AREA. As in the previous figure a beach line or gravel and sand deposit is indicated. The marked difference in vegetation is very noticeable. Tamarack (T) on one side and Spruce (S) on the other indicate wetter ground conditions.



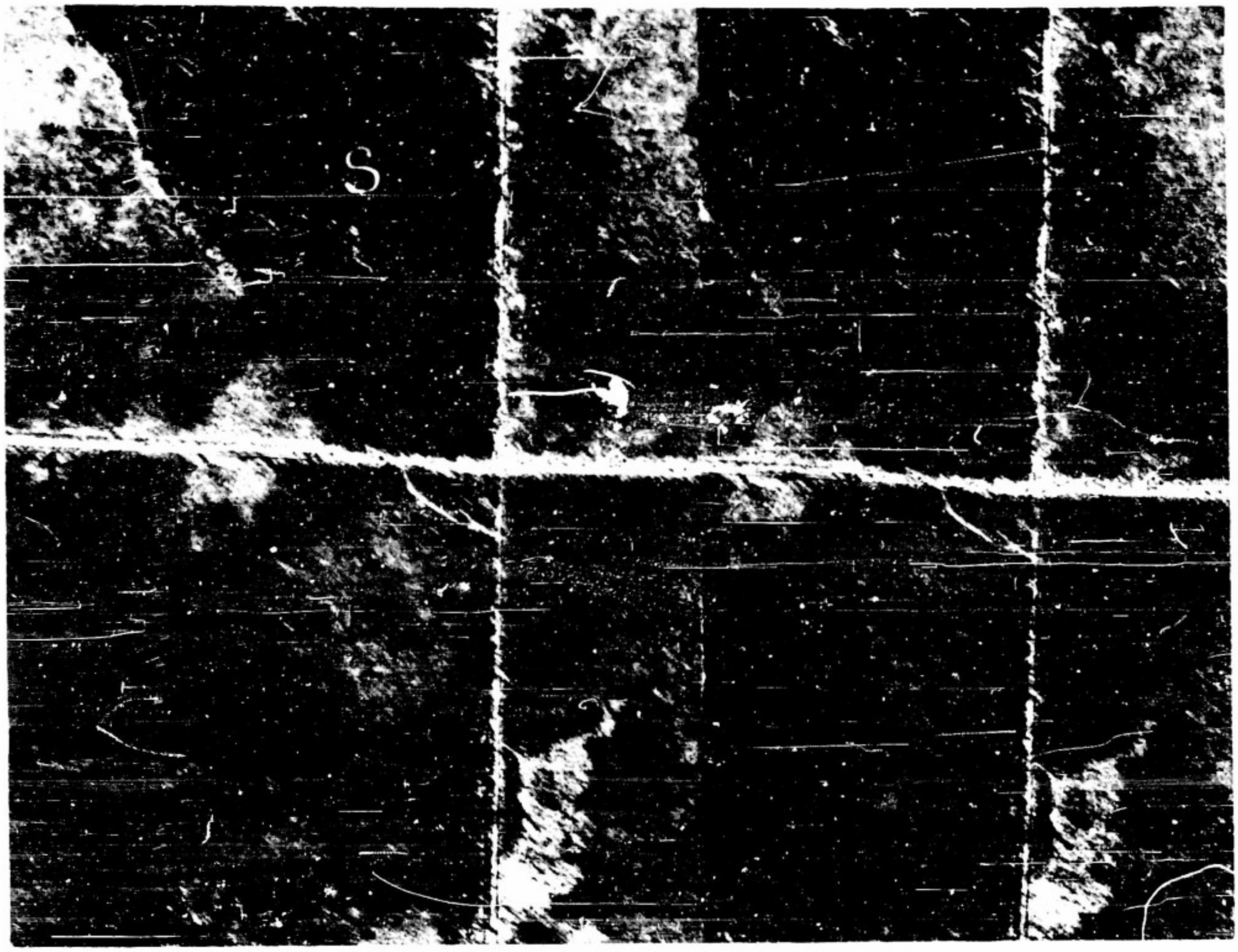
Scale 1:7,500

Fig. 118 - KOOCHICHING AREA. Drier land and better drainage conditions near the streams and rivers is indicated by the absence of the common swamp species, such as Spruce (S), along, or near, the river banks. That the streams do not drain great areas is indicated by the presence of drainage ditches (1) in the vicinity. Regular swamp vegetation will grow adjacent to roads (2) but very seldom adjacent to the drainage ditch. Better developed paths appear in the drier sections, usually near the streams.



Scale 1:20,000

Fig. 119 - KOOCHICHING AREA. The principal indicators in the large swamp regions are the Spruce (S) and Tamarack trees. The Tamarack will develop on wetter ground than the Spruce. In this particular photo the Tamarack is small and under developed due to the excess amount of moisture, thus is classified as stagnant Tamarack (Tx). Its light tone distinguishes it from the dark toned Spruce. The lowland brush (Lb) is distinguished from the stagnant Tamarack by the difference in the height of the vegetation. The straight line across the photograph is one of the drainage ditches that has been dug through the swamps of the Koochiching Area. A portion of this same area is shown on Figure 120.



Scale 1:7,500

Fig. 120 - KOOCHICHING AREA. This stereo pair covers a part of the same area as shown in Figure 119. The two should be compared as they show the difference in tone and texture for the winter and summer seasons. On the winter photos both the Spruce (S) and the stagnant Tamarack (Tx) have a much darker tone than on the summer. On the winter photos the drainage ditch (1), and the logging road beside it, are white because of snow cover. On the summer photos the ditch appears black because of water.

Fig. Multicolored

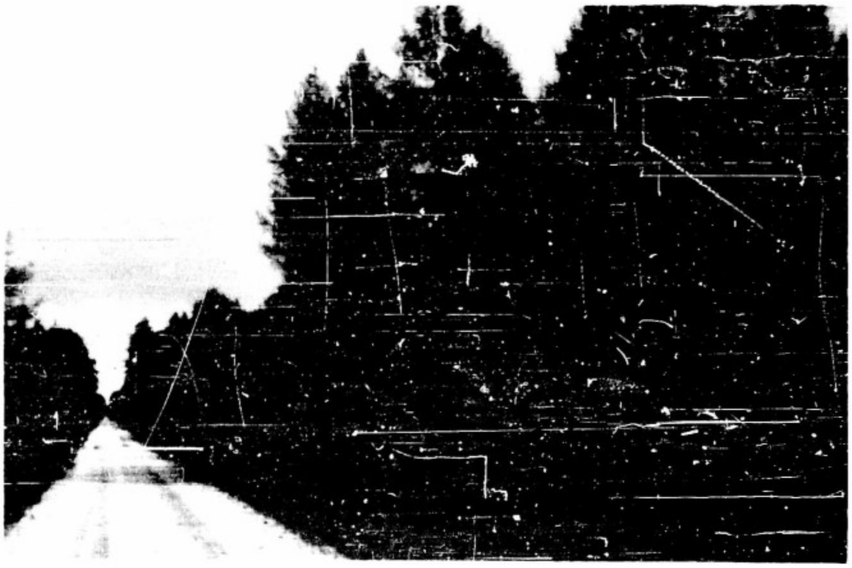


Fig. 121 - Tamarack is one of the key trees for the identification of swamps in the Boreal Forest area. In North America the Tamarack extends from the McKenzie River Valley through the Great Lake area into West Virginia and on to the Atlantic Coast in Nova Scotia and Labrador. The trunk is usually straight and may reach a height of 60 feet along the southern edge of the Boreal Forest area. Very seldom does the thickness of the trunk exceed 22 inches. It is distinctively a tree of swampy lands venturing further out on low lake shores and sphagnum bogs than any other tree excepting perhaps the Black Spruce. In the summer the foliage is a pale green but during the autumn it changes to a bright yellow. The wood from this tree is durable when in contact with the soil. It is suitable for railroad ties and posts.

FIG. MULTICOLORED

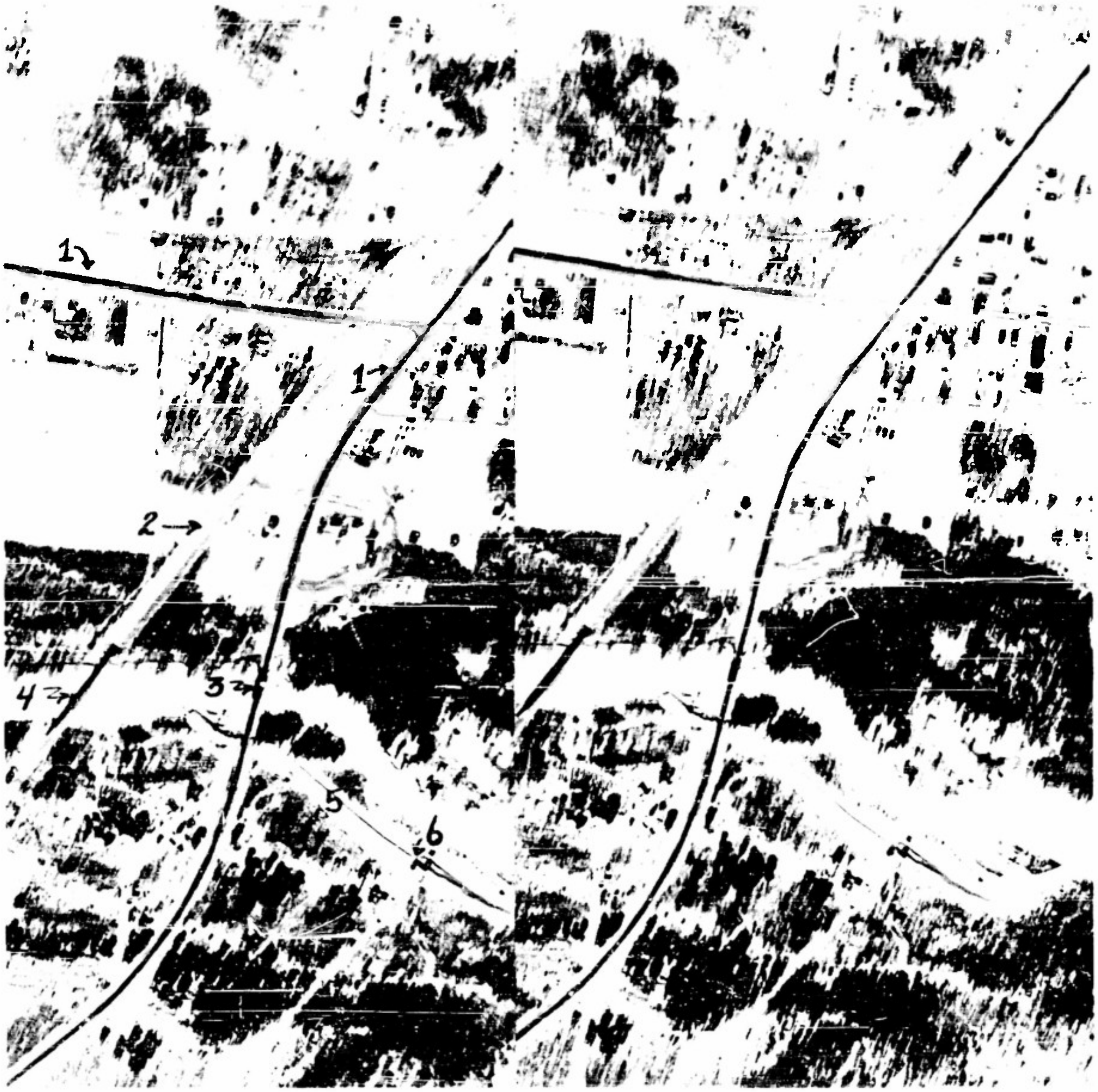
Fig. 122 - Erratic boulder beside the road in the Pine Island refuge of the Koochiching Area. A thick deposit of gravel drift has elevated this area slightly above the poorly drained bog and marsh area surrounding it. Thus, there is a growth of better trees.

Fig. 123 - In 1909 a drainage program was started in the Koochiching Area. Ditches were dug so as to cross each other at two-mile intervals. It was soon realized, however, that the ditches were not accomplishing the desired results. The entire project was abandoned in 1918.

Large ditch digging machines were floated in the ditch they dug. The men operating the digger lived in a house built on it. The fuel supply was stored in drums and floated back of the rear platform. The scooped out material was piled along the bank. Due to the physical condition of the area through which they were dug little drainage took place. The ditches did fill with water and some of the land adjacent to the ditches dried out somewhat. It was soon learned that the drained soil was of little value for cultivation.

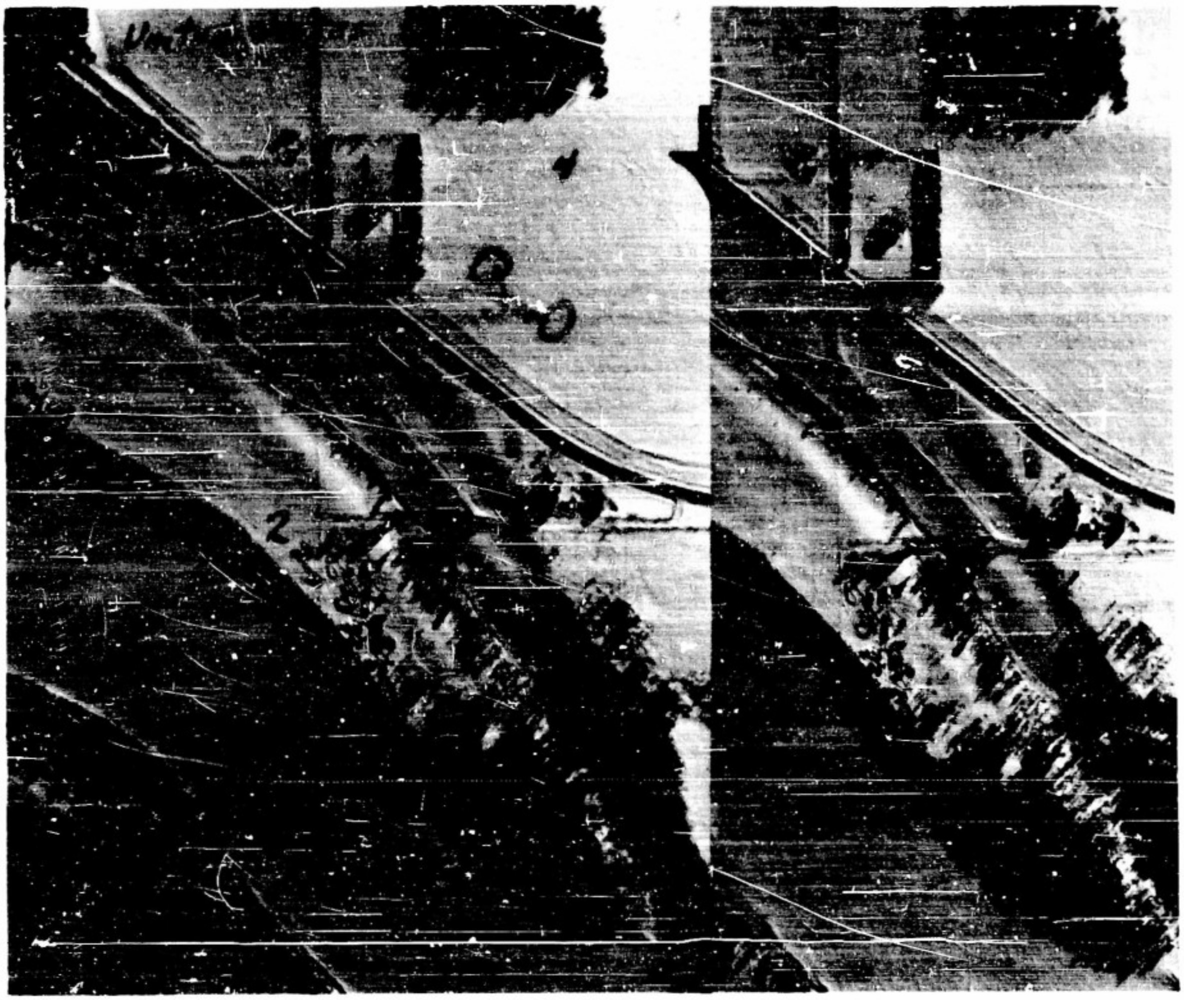
Since the abandonment of the project, beavers have come into the area. They have built dams across many of the ditches causing more of a water problem than previously. Moose and deer also roam freely through this vast swamp area.

Fig. 124 - Large and heavy road building equipment is required to construct modern roads through the vast swamps of the Koochiching Area. The group shown here is in the process of filling a bog 42 feet deep and approximately 600 feet across so that a county road can be completed. They have been dumping material into the hole for four months and estimate they are about two-thirds finished. Suitable filler material needs to be hauled only a short distance since a large supply of rock and gravel is near. As material is poured into the bog it slowly settles and pushes the peat and other substances to the side. As the fill builds up, the roads are constructed so that the large machines use the road they are building.



Scale 1:7,500

Fig. 125 - KOOCHICHING AREA. The village of Big Falls is practically surrounded by swamp and marsh areas. Winter photos make the identification of many cultural items extremely easy. The much used asphalt highways (1) have a very dark tone compared to the white tone of secondary roads. The railroad bed (2) is white but the parallel rails are visible as dark lines when in stereo. The type of highway bridge (3) and the type of railroad bridge (4) can be identified by their shadows. A power canal (5) leads from the river to the power plant (6). The falls from which the village gets its name are directly under the highway bridge.



Scale 1:7,500

Fig. 126 - KOOCHICHING AREA. The Rainy River forms part of the boundary between the United States and Canada. Between International Falls and Baudette there are no villages of importance. There are, however, many rural schools with their enclosed yards (1) and small groups of cottages (2) that are used by summer tourists. Electricity is supplied by the REA. The lines can be followed by the pole shadows (3). Fenced fields can be determined by the fence rows (4). All cleared areas will have Spruce (S) and other trees within or bordering them.

Fig. 127 - Looking across a Christmas tree bog in the northern part of the Koochiching Area. Although the swamp area in the distance looks to be very dense the density is not much greater than that shown in the foreground.

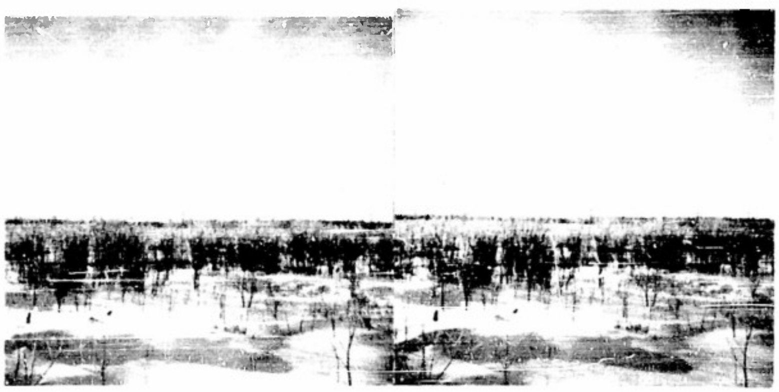


Fig. 128 - A burned Spruce area 4 miles southeast of Clementson. In the background can be seen the live Spruce in that part of the swamp which was not damaged by fire.

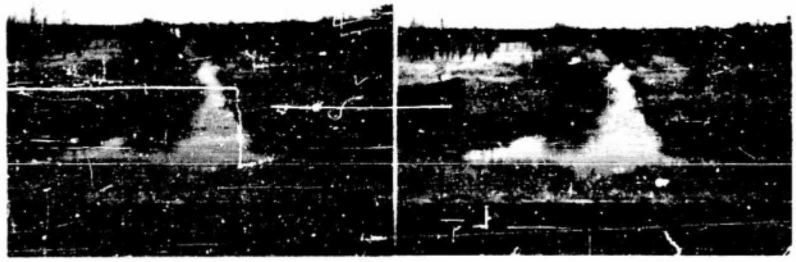


Fig. 129 - Grass and Alder swamp that is being used as a state game refuge. It is located 25 miles south of Rainy River on Minnesota State Highway No. 72.

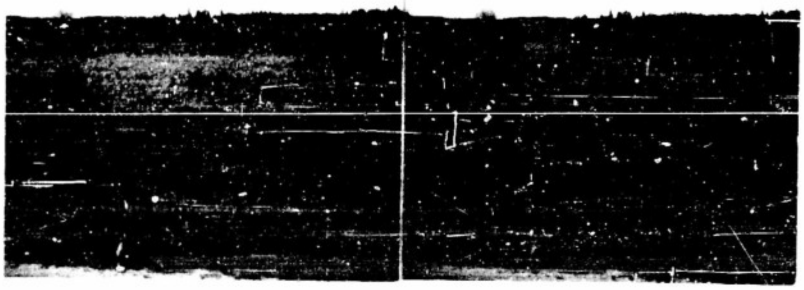


Fig. 130 - Typical marsh land of the Koochiching Area. Spruce standing in the background indicates the marsh grades into a swamp.

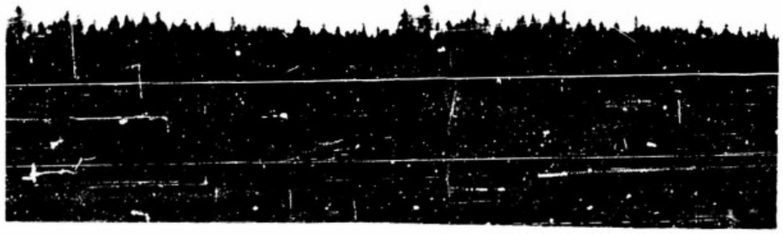


Fig. 131 - Spruce swamp located 6.5 miles southeast of Clementson.

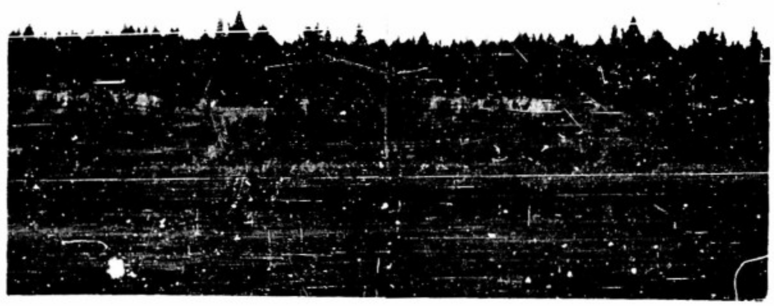


Fig. 132 - Tamarack swamp located at the northeast corner of Upper Red Lake approximately 2 miles north of Waskish.

Chapter IX

THE ITASCA AREA

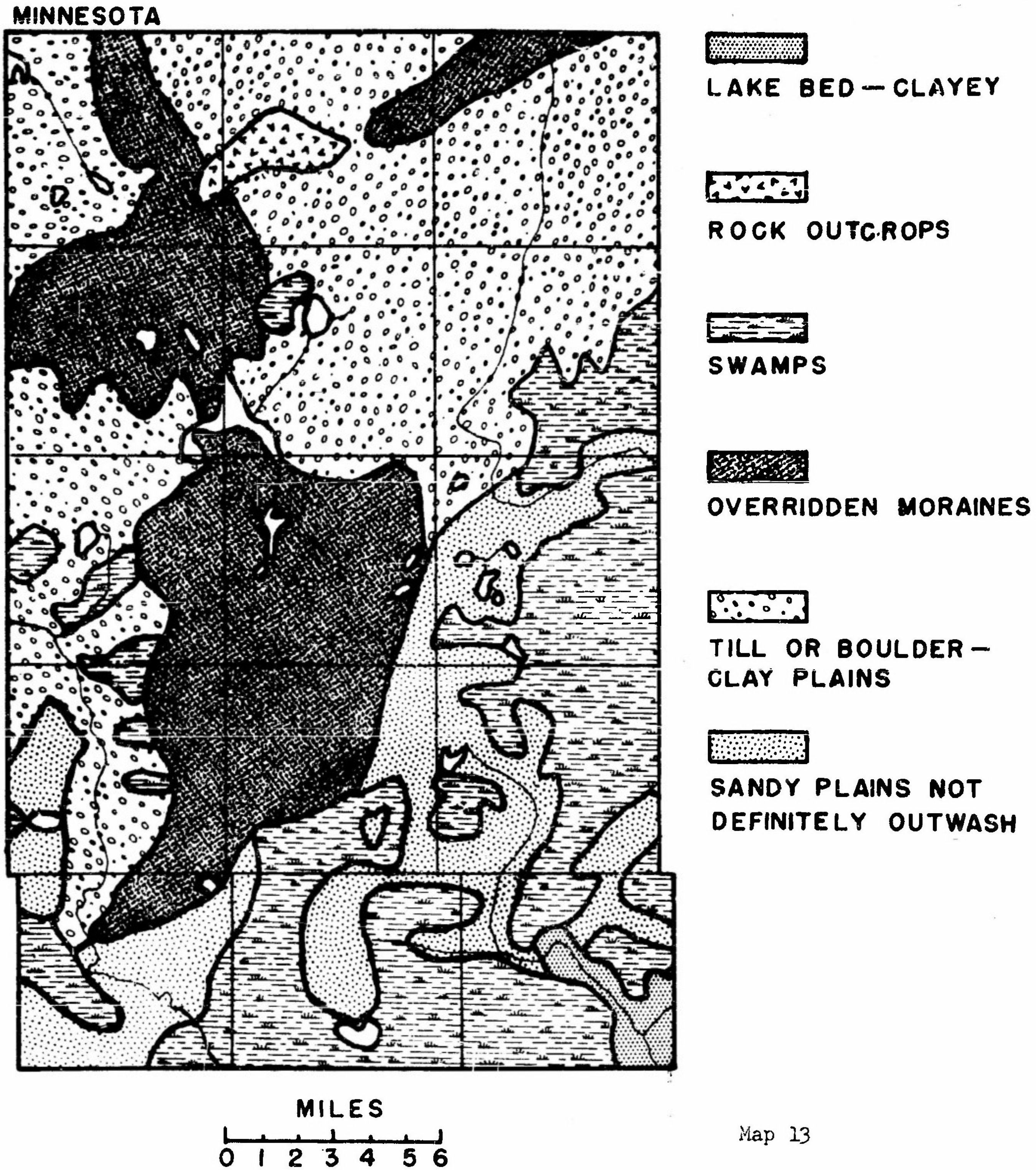
In the Itasca Area can be found a common point of union between each of the other three areas. Some of the rock outcrops from the Ely Area extend into the northern part of the Itasca Area. Moraines from the Hubbard Area extend into the western part. Scattered throughout the Itasca Area is a large series of swamps. Although these swamps are not a result of the filling of Lake Agassiz they have been caused by similar swamp making conditions. In this area, where the conditions from the other three areas meet, one does find, then, rock outcrops, moraines and glacial lake swamps repeated in all types of confusion. Intermixed with these conditions are areas of good farmland, large streams, particularly parts of Swan River and the Mississippi River, and areas of good forests.

Grand Rapids is the largest city in any of the areas studied in detail. The influence of this city has resulted in more and better roads and more cultural activity in general than is found in either the Ely, Hubbard or Koochiching Areas.

Geology

Map 13 shows the surface geology of the Itasca Area. Much of the western and northern borders are covered with till or boulder clay plains. Throughout this part of the area erratics and large boulders can be seen. A large overridden moraine occupies much of the west part of the Itasca Area. In this moraine can be found numerous small lakes and swamps. Sandy plains are the best drained areas. Streams of varying

ITASCA AREA



Map 13

sizes reach their best development on these plains. Along these streams will be found many meanders and ox-bow lakes which have been formed as the streams have wandered from place to place crossing relatively level land.

The southeastern part of the Itasca Area is largely swamp land. This swamp is the remains of the St. Louis swamp which was first crossed by Marquette and Joliet when they discovered the upper Mississippi River. Although a few drainage ditches have been dug, no attempt at drainage has been made to the extent that was done in the Koochiching Area. A few parts of this swamp are relatively dry during the summer season. One of the largest swamp areas is named Dry Lake.

In the northern part of the Itasca Area one finds the great iron ore mines of the Mesabi Range. A few abandoned iron ore pits will show on aerial photographs as lakes, however, the activities near them will indicate that they are a result of man's activity and not of glacial activity as are the other lakes within the area.

Topography

The Itasca Area is relatively level when compared with the Ely or Hubbard Areas but would be very rough and rugged if compared with the Koochiching Area. A few ridges occur in the northeastern part of the Itasca Area where the iron mines are located. In general, drainage is to the south or southeast, however, it is not unusual to find streams flowing in exactly the opposite direction from which it seems they should flow. Most of the streams flow eventually into the Mississippi.

Like the Ely Area there are many clear lakes in the Itasca Area.

ITASCA CO. AREA

0 1 2 3
STATUTE MILES

MAP 14

Swan Lake, Pokegama Lake, McCarthy Lake, Cow Horn Lake, and others are of fairly large size. In each case the land around these lakes is generally low rolling hills covered with forests. Thus, in most instances, recreational activities have been built along their shores.

Swamps and Bogs

In the Itasca Area swamps and bogs can be found in practically every stage of development. On aerial photographs the old shore lines of now filled lakes are quite evident. Tall trees, usually aspen or some other deciduous species, grow on the higher, drier shore lines (Fig. 11). Near the center of these old filled lakes can be seen the remains of drainage ditches or stands of small swamp vegetation. In most cases the old lake beds are still too soggy for regular agricultural usage.

The shore line of Dry Lake is very evident in aerial photographs (Fig. 133). This particular lake is overgrown with alder brush and marsh grasses. Some attempt has been made to drain it but without success. In one part of the lake is a high sandy island which is drier than the land that surrounds it. On this island is a good growth of popple instead of the regular swamp brush. During the winter season it would be possible to travel over parts of such lakes after they have frozen over, however, a difficult problem of cutting through the brush would be presented.

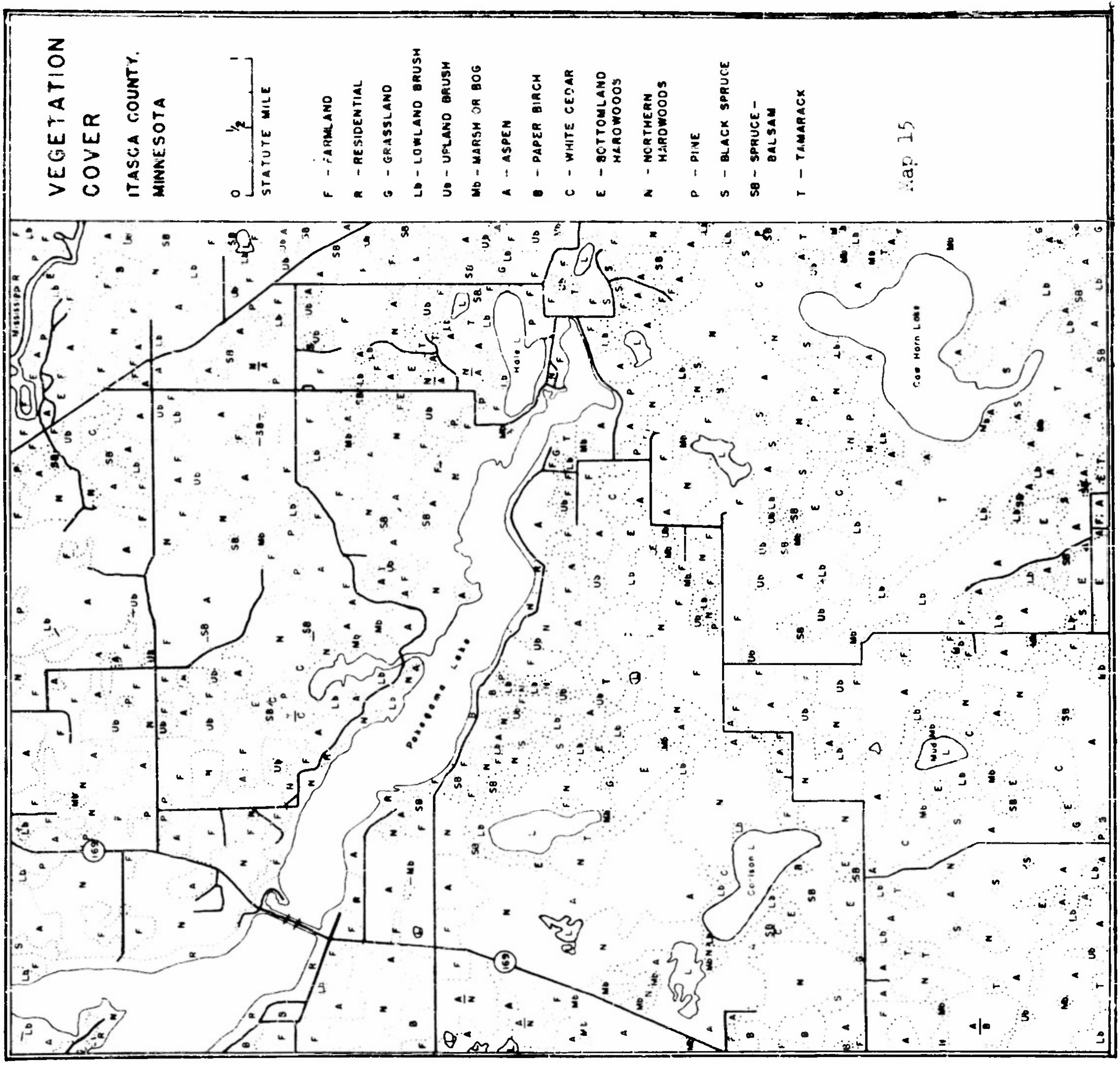
Another swamp area is in the making on what is called Layton's Cove which is a part of Swan Lake. This Cove is in the southwest corner of the Lake. The Cove is extremely shallow in spite of its size. The

depth of the water is from twelve to forty inches, while in the channel the water reaches a depth of forty-eight inches. The bottom is extremely soft and silty with very little sand. The vegetation of the Cove is wild rice and water lilies with rice being the predominating one. At the time of field work in the area, June 18, 1953, only occasional rice stalks were protruding above the water and the lily pads had not yet reached the surface. Those who have lived in the area stated that later in the summer, probably late August, the area would be entirely covered with a dense growth of rice and only the channel would remain clear at the surface. It was further remarked that from the air the Cove would appear to be a very flat pasture since all the water surface would be covered. Stalk water vegetation appeared only near the edges of the Cove where the bottom was hard and sandy.

<u>Vegetation</u>

The aspen-birch type of forests form the principal types in the Itasca Area (Map 15). This forest is composed primarily of trembling aspen in mixture with paper birch, large tooth aspen, oak, and balsam fir. Many stands have under stories of conifers or hardwoods. Northern hardwoods in general are widely distributed.

Formerly jack pine covered many square miles of territory in the Itasca Area. Much of the jack pine grew on the heavier soils, which after cutting are subject to invasion by more tolerant tree species and brush. Thus, once the jack pine was cut it had some difficulty in regenerating on these same soils. Norway pine occurs only in a few places.


VEGETATION COVER
ITASCA COUNTY, MINNESOTA
0 ½ 1
STATUTE MILE
F - FARMLAND
R - RESIDENTIAL
G - GRASSLAND
Lb - LOWLAND BRUSH
Ub - UPLAND BRUSH
Mb - MARSH OR BOG
A - ASPEN
B - PAPER BIRCH
C - WHITE CEDAR
E - BOTTOMLAND HARDWOODS
N - NORTHERN HARDWOODS
P - PINE
S - BLACK SPRUCE
SB - SPRUCE-BALSAM
T - TAMARACK
Map 15
Mississippi R
Pokegama Lake
Hale L
Cow Horn Lake
Carlson L
Mud L

Spruce-balsam growths are common throughout the area. Black spruce, tamarack and cedar are common in the lowlands around the swamps. In many of the spruce-fir sites, both coniferous and deciduous trees are abundant. Their distinction from each other on aerial photographs, however, is relatively easy, especially when winter photography is used. Late summer or fall panchromatic photos will also show the difference because of the characteristic light tones of the deciduous trees and the dark tones of the coniferous trees. During the main part of the summer season there is less variation in tone in the vegetation, thus distinction is more difficult. The soft woods will generally photograph somewhat darker and have a more regular and finer texture. Their pointed crowns and the fact that with the exception of pines they occupy regions of lower topography also can be used as indicators.

In general the hardwoods fall into two broad groups. The pioneer hardwoods, which have been mentioned in previous chapters, are the aspen, paper birch and closely related species. The tolerant hardwoods are maple, beech and yellow birch. In general these two groups can be distinguished on aerial photographs by the finer texture of the pioneer hardwoods which is caused by their small flat crowns of uniform appearance. The tolerant hardwoods are characterized by larger and more rounded crowns and have a pebbled texture. Aspen will have a feathery appearance in the spring photos. Occasionally they can be identified by their shadows.

Transportation

In the Itasca Area transportation will not be a particular problem

for the rock outcrops, moraines or till plains except in the vicinity of small swamps and bogs. In the winter season large lakes the size of Swan Lake have an ice cover with a thickness of thirty to forty-eight inches. This thickness easily supports the weight of cars and fishing shacks. The ice cover will appear in early November and last until the middle of April. The thickness of the ice naturally depends upon the severity of the winter. The colder the winter and the less the snowfall the thicker the ice cover will be.

Most of the logging is done in the winter but some is done all year long in the sandy areas. In the swamps and bogs most of the logging is done in the winter so that there will be less difficulty in getting the logs out. As soon as the water freezes hard the snow is packed for trails to aid in further freezing. Heavy machines can then be taken into the swamps with relatively little trouble. The one big problem in such swamp areas is to locate springs. Occasionally the water will freeze over the top of the springs, causing them to look like any other part of the frozen lake bed. However, where there is a spring the ice is very thin. When the water is frozen over the spring, the spring cannot be detected from photographs. Thus, there would be a possibility of walking or driving a piece of heavy equipment over thin ice. Some logging could be done in the swamps during the summer season, however, the insect problem becomes so great that it is generally not attempted.

Before the modern paved roads were put into the Itasca Area much winter travel was done by skis and snowshoes. In the summer, boats were used if there could be a path cleared through the swamp growth.

The securing of road materials in most of the Itasca Area is not a problem. Stones and sand are available. The paved roads that have been put down in the Itasca Area are affected by weather conditions. In many cases the freeze and thaw has been so bad that the beds buckle and crack. Heavy machines and trucks used in the iron idustry have presented a particular problem in this area because of their number and size.

Cultural Factors

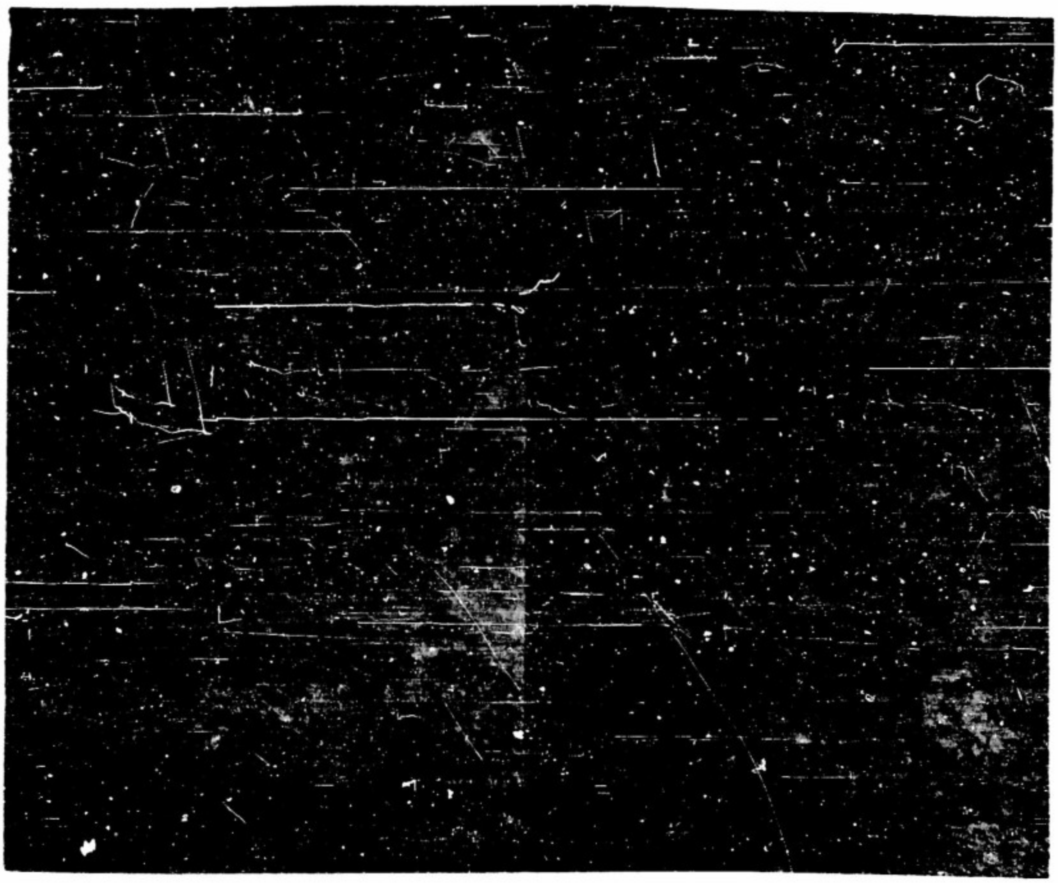
The Itasca Area, unlike the other three areas, has several cities in it. These cities have developed because of the iron mining activities. Several small crossroad villages have also sprung up near the better agricultural areas. In most instances these cities and villages are connected by paved highways. Because of the greater population density more county roads have been constructed so that school bus routes may be developed and the mail delivered.

Many farms in the Itasca Area will have rock fences. These rocks have been taken from the stony fields and used to build the fence rows. Boulders and pebbles appear in almost every plowed field. In general, however, those fields that are exceedingly stony are not plowed but are left in pasture. When the hay or grass crops get high enough to cover the rocks the fields look like ones of smooth and regular surface. In most instances the rocks are not large enough to be detected in aerial photographs. They are large enough, however, that if a plane should attempt to land in such a field it would be completely wrecked. Farm homes will vary in size and condition with the land upon which they are built.

The great iron mines of the Mesabi Range present a peculiar appearance in aerial photos. They are great man-made depressions which appear to have a series of gigantic steps coming down into them. On some of the photos the trucks and ore cars can be seen. Such places might be the result of Paul Bunyan and his famous Blue Ox if the iron miners would add a little more to the story.

Conclusions

In the Itasca Area can be found conditions that somewhat resemble the conditions in each of the other three areas. Here the various problems of photo interpretation are presented in closer unity with each other. Swamps, bogs, moraines, ridges, rock outcrops, valleys and all the physical features combine with the various plant associations to make such an area a photo interpreter's nightmare. The problem of presenting a clear picture is going to be almost an impossible one because of the intermixture of largeness and smallness, extremes and averages.

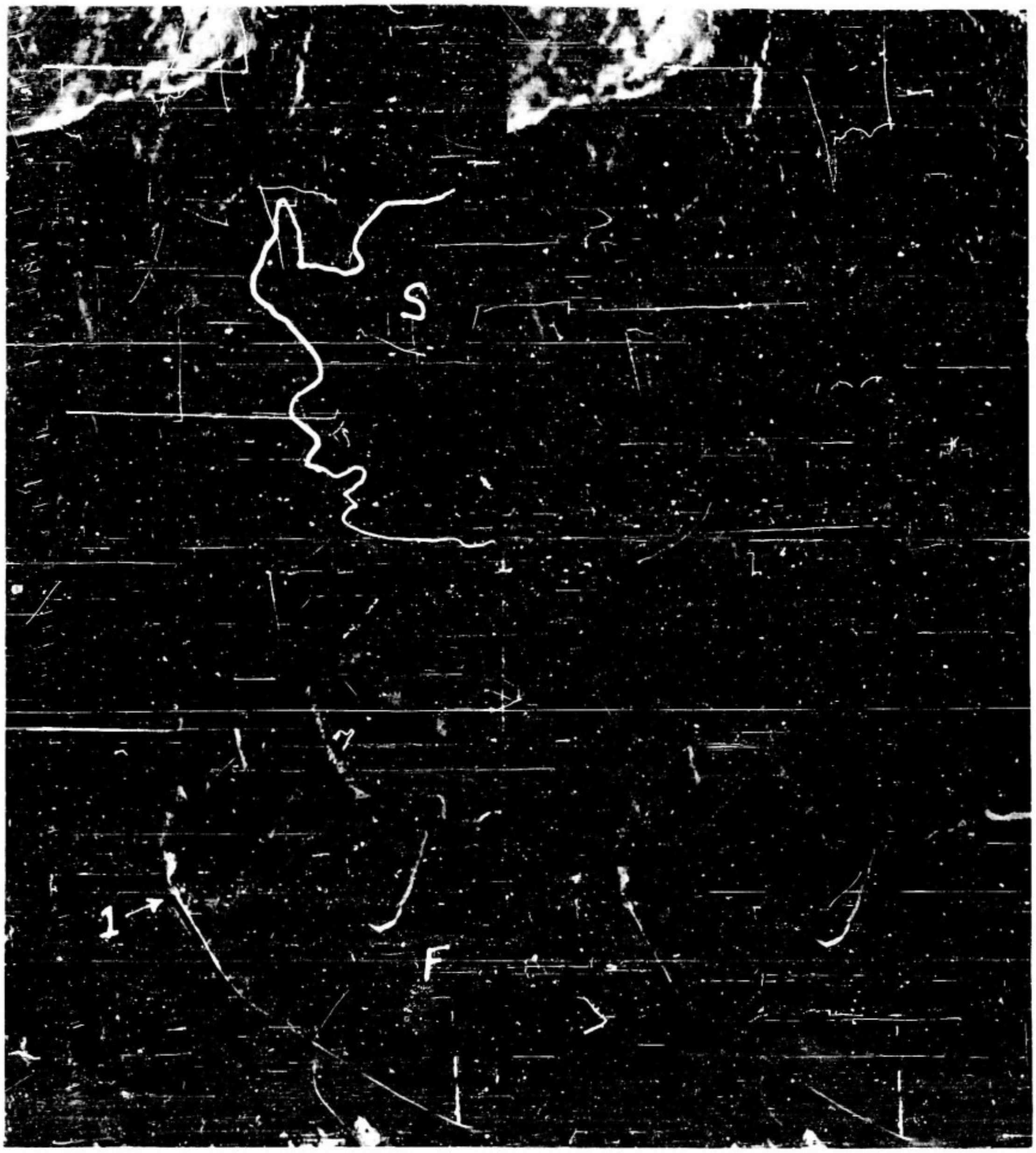


Scale 1:10,000

Fig. 133 - ITASCA AREA. This large swamp, located in the southeastern part of the Itasca Area, is known locally as Dry Lake. The shore line of the former is partly marked by a ring of trees, mostly Tamarack (T). There is a drop of one to three feet from the shore into the lake bed proper. The lake bed gradually increases in depth toward the center. A growth of Alder Brush (`b) mixed with marsh grass (Mg) covers practically all the lake bed. An attempt at drainage was made, as is indicated by the drainage ditch (1), but it proved unsuccessful. Figures 71 and 72 show other characteristics along one edge of Dry Lake. Figures 146 and 147 are photos across the lake at different seasons.

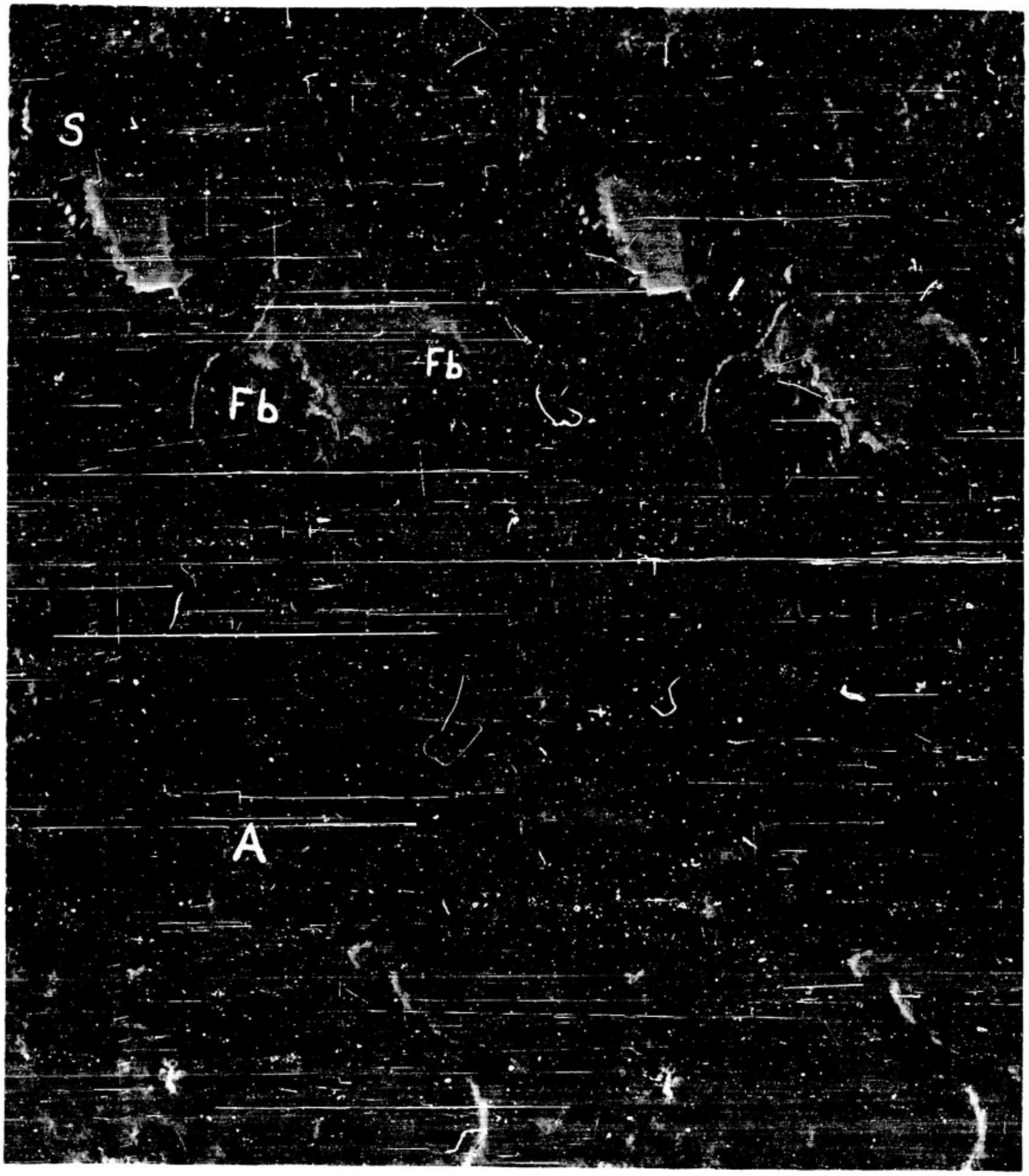
Scale 1:10,000

Fig. 134 - ITASCA AREA. Areas of farmlands (3) and swamps (Sw) adjoin each other in many parts of the Itasca Area. Farmsteads (2) having many buildings are connected with the highways (1) by good secondary roads. Spruce (S) is the best indicator of the swampy areas while hardwoods, mostly Aspen (Ha), grow on the higher and drier ground.



Scale 1:6,800

Fig. 135 - ITASCA AREA. This set of stereo photos is extremely dark. A light snow remains on the ground where the lightest tone is observed except for the snow and ice covered lake. The darkest tones, however, are in the Spruce (S) covered area. Numerous trails can be identified by the snow remaining in them. Highways and roads (1) follow the hillside or divides rather than the valleys whenever possible. Large depressions are sometimes found in otherwise level farm (F) lands.



Scale 1:6,800

Fig. 136 - ITASCA AREA. This stereo pair shows good examples of floating bogs (FB) as seen on winter photographs. Usually the tone will not be so dark. The low area near the lake is covered by Spruce (S) while the hilltops and hillsides have mostly Aspen (A).

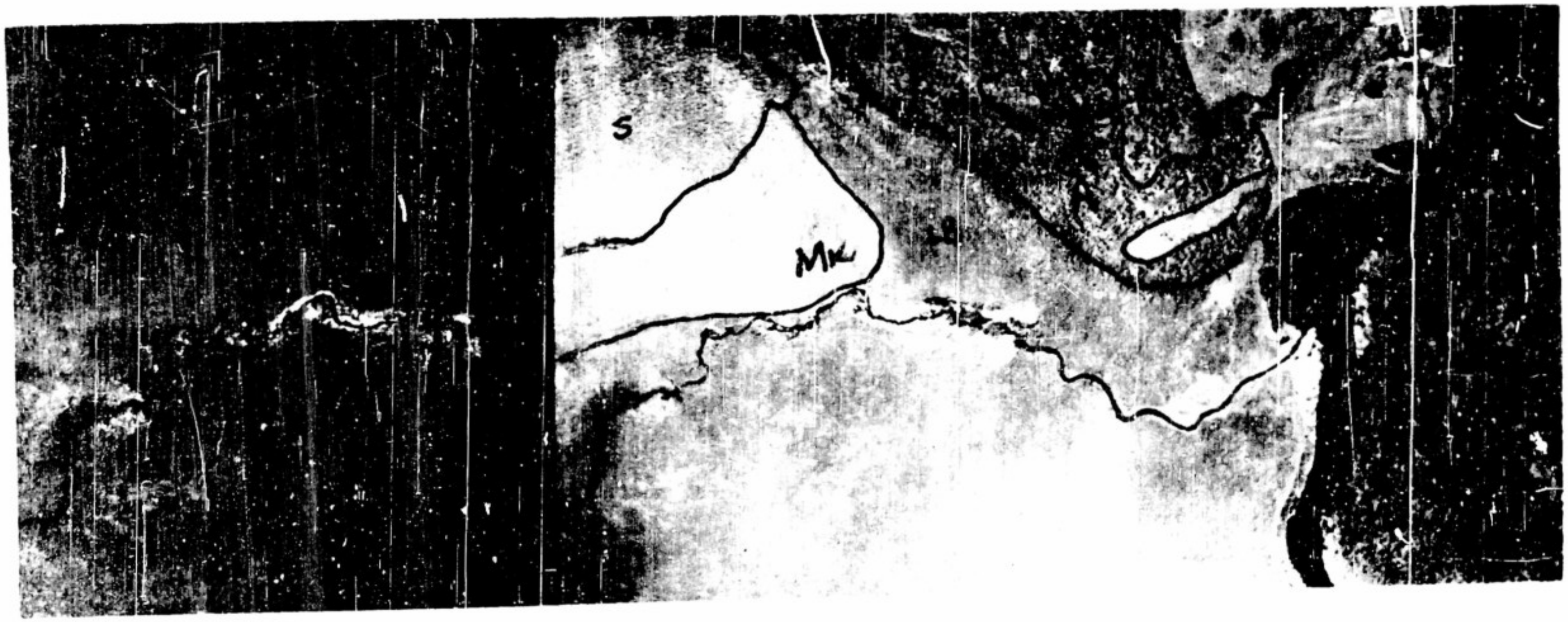
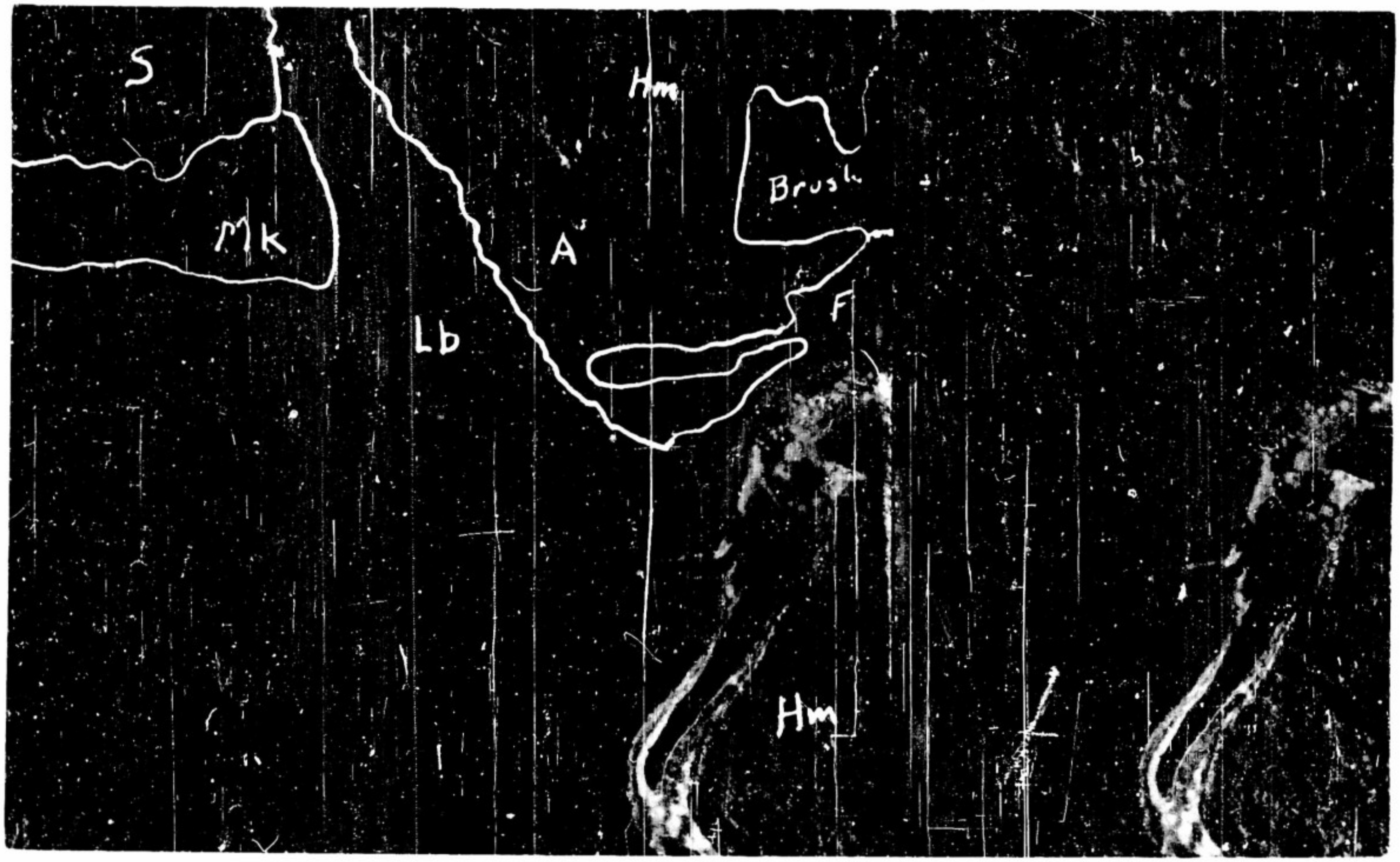


Fig. 137 - ITASCA AREA. The wide variety of vegetation and moisture conditions illustrated in this stereo pair are located near Swan Lake. These photos should be used in conjunction with Figure 138 which is of the same area during the winter season. The areas of mixed hardwoods (Hm), Aspen (A) and Farm land (F) occupy the highest and driest ground. The lower and more moist areas are covered by lowland brush (LB), Spruce (S) and muskeg (Mk). Variation in tone and texture in two overlapping photographs is well illustrated.



Scale 1:6,800

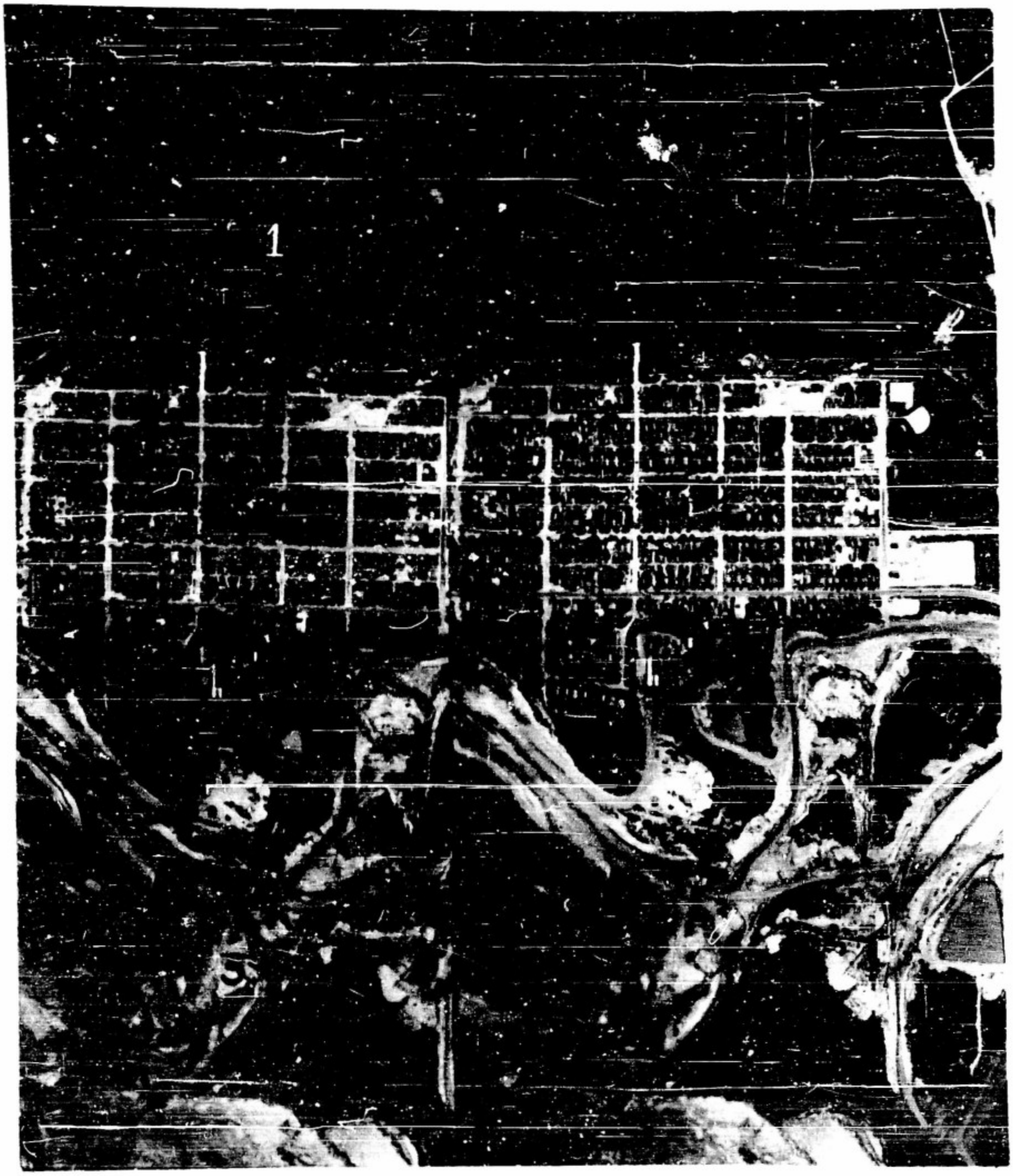
Fig. 138 - ITASCA AREA. This stereo pair should be studied in conjunction with Figure 137.

Scale 1:15,840

Fig. 139 - ITASCA AREA. This infra-red stereo pair is excellent for studying the differences in tone, texture and shape of three trees, Spruce (S), Tamarack (T), and Jack Pine (Pj), which often confuse the photo interpreter. An area of water killed Spruce (1) has been outlined. Such places are to be avoided by all vehicles. A small marsh (M) area is located near the lake.

Scale 1:10,000

Fig. 140 - ITASCA AREA. Muskeg (Mk) surrounded by stagnant Tamarack (Tx) is common in many parts of marsh and swamp areas. Such places are to be avoided by all types of vehicles. Lowland brush (LB) areas are also likely to be moist and cause transportation difficulties. The common upland hardwood shown here is Aspen (A). Upland brush (UB) will also occupy some of the higher places. Areas level enough for farms (F) will probably be in cultivation.



Scale 1:10,000

Fig. 141 - ITASCA AREA. The city of Nashwauk is located in the Mesabi Iron Range. The principal activity is the mining of iron ore. Large dumps (1), so old that they have been overgrown, adjoin the city on one side while a large open pit mine (2) is located on the opposite side. Material is moved from the mine by conveyor belt (3) as well as by trucks. Many identifying cultural features are shown in this stereo pair.

Fig. 142 - Layton's Cove is located in the southwest corner of Swan Lake. The cove is extremely shallow in spite of its size, the depth of the water varying from 12 to 40 inches. The bottom is soft and silty. Very little sand was found.

The vegetation of the cove is wild rice and water lilies with rice dominating. At the time this picture was made, June 18, 1953, only occasional stalks of rice were protruding above the water and the lily pads had not yet reached the surface. The local people stated that by late August the surface would be covered with a dense growth of rice. It was also stated that from the air the cove would appear to be a flat pasture. See Figure 144.

Fig. MULTICOLORED

Fig. 143 - A view to the southwest across Trout Lake in the Itasca Area. The tussock meadow has developed on poorly drained organic soils. The water table varies from 3 to 6 inches beneath the surface. The footprints of cattle fill immediately with water after the spongy vegetative and mineral soil material is depressed by weight.

Fig. 144 - Wild rice growing in Swan Lake Cove. This picture was taken July 25, 1952.

Fig. 145 - Typical winter scene looking across a Black Spruce swamp.

Fig. 146 - Looking across Dry Lake toward Popple stand, January, 1953. See Figures 71, 72, 133 and 147.

Fig. 147 - Same area as Figure 146. Picture was taken in April, 1953, at the time of the spring thaw.

Fig. 148 - Stony farm land located 7 miles southwest of Grand Rapids, Minnesota. With the growth of the crop or pasture the stones become less visible. From the air such a field might appear to be a suitable landing place for a plane.

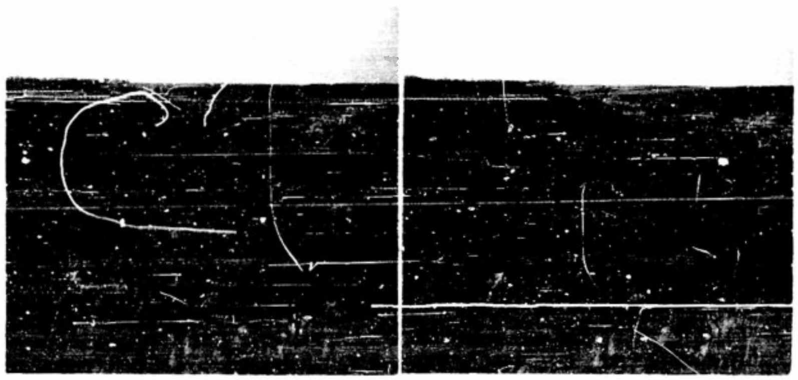


Fig. 149 - An open iron ore pit near Hibbing in the Mesabi Range.

Chapter X

SIMILAR AREAS IN EUROPE

There are many features of the southern edge of the Boreal fringe areas of marsh and swamp land in Europe that are quite similar to those in the United States. The indicators used in the previous chapters of this report will to a large extent be indicators of these similar areas in the various sections of Northwestern Europe. It must be understood, however, that due to the differences in culture between the North American areas and the European areas that the building types, roadways, cities, cemeteries and other such features will have a far greater variation than the physical features within the two areas.

Dr. Preston E. James has described the Boreal Forest lands as follows:

> Seasonal change reaches a maximum in the Boreal Forest lands. In no other part of the world does the aspect of the face of the earth undergo such a radical transformation in the course of the year, as in these forest lands of the higher middle latitudes of the Northern Hemisphere. The intense cold and long hours of darkness during the winter enforce on the vegetation a long period of rest. During this time the contour of the land is smoothed by a blanket of snow, and the rivers and lakes are locked in a casing of ice. At first the longer hours of sunlight in the spring seem to make little impression on the frozen land; but suddenly, in May or June, the bare ground is revealed, the ice breaks up and is carried down stream in great thundering, chaotic masses, and the long slumbering vegetation almost bursts into vigorous life. A carpet of flowers quickly covers the ground left bare by the melting snow, and the air is filled with myriads of insects. This is the brief period of breathless activity for all the inhabitants of the forest,--all except man, the intruder, who finds travel difficult when he tries to penetrate the thick forests and bogs away from the navigable rivers. Only where agriculture is attempted is this a busy period for the human inhabitants. With the first touch of fall the broadleaf trees turn yellow or red, the insects disappear, and the land animals seek a shelter for the long winter hibernation. Great numbers of

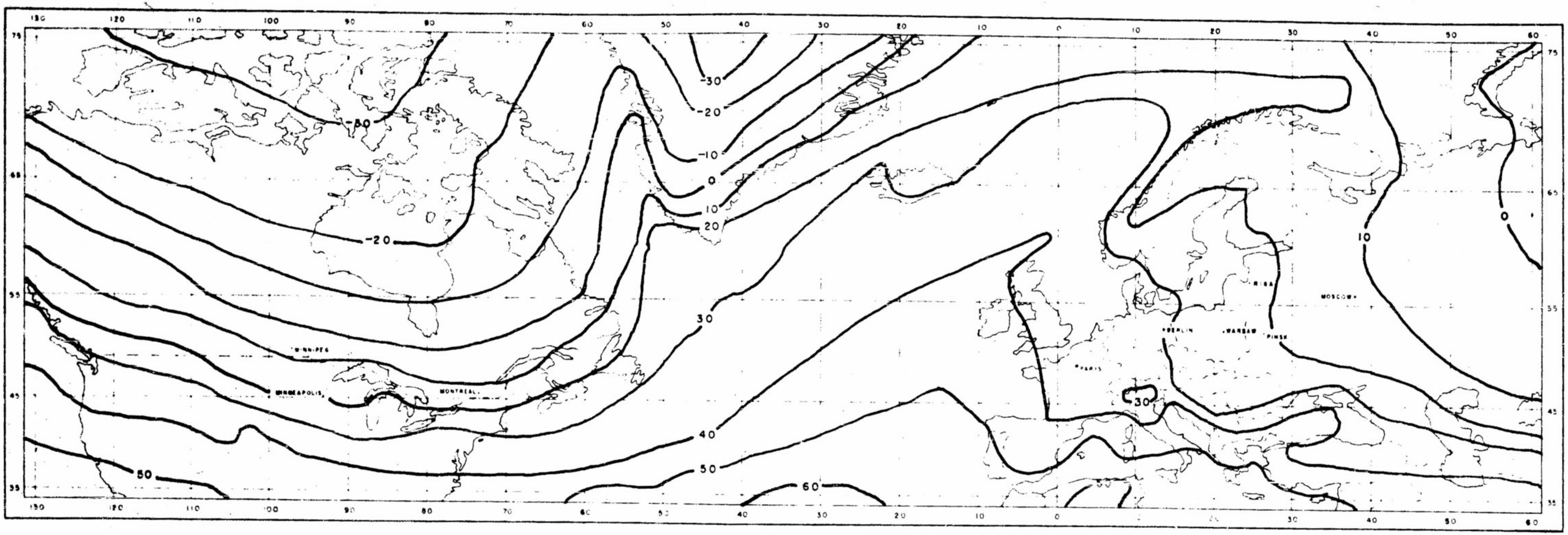
migrating animals, especially birds, start southward. First with a touch of frost, then more firmly with a grip of ice and snow, winter fastens its fingers on the land. The long, dark night sets in. Then, from their refuge near the rivers, men move out into the forest, traveling easily on skis or snowshoes or sledges over the snow covered surface or along the smooth ice-covered rivers. These are the hunters, trappers, and lumbermen who extract from the forest at this time its toll of timber and firs. No landscapes, not even those of the tropical savannas, could change more than this in the course of a year.*

Maps 16 through 30 show the likenesses and variations between the areas studied in Minnesota and the adjoining states and provinces and similar areas in Europe. From Map 16 it will be noted that the mean sea level temperature, in Minnesota, in January is between 10° and 20°. In Europe these same temperatures are found to range from Moscow to approximately the Polish border. Map 17, which gives the mean sea level temperature for July, shows that 70°F. is common to both the American and European areas. However, when the temperatures for the complete year are plotted, it is found that the mean annual temperature range, Map 18, indicates that the European area from Moscow to the Polish border is less than that of the Minnesota area of North America. The annual precipitation in much of Northwestern Europe as well as the areas studied in North America ranges between 20 to 40 inches as is shown on Map 19. The number of cloudy days in January in the European and American areas is approximately the same, in North America being five and in the Pinsk and Baltic coast areas being seven as indicated on Map 20. Map 21 shows the mean cloudiness in July. Again the remarkable similarity between these two areas is apparent and the number of cloudy days

*James, Preston E., <u>Outline of Geography</u>, (Boston, Ginn and Company, 1943) p. 261.

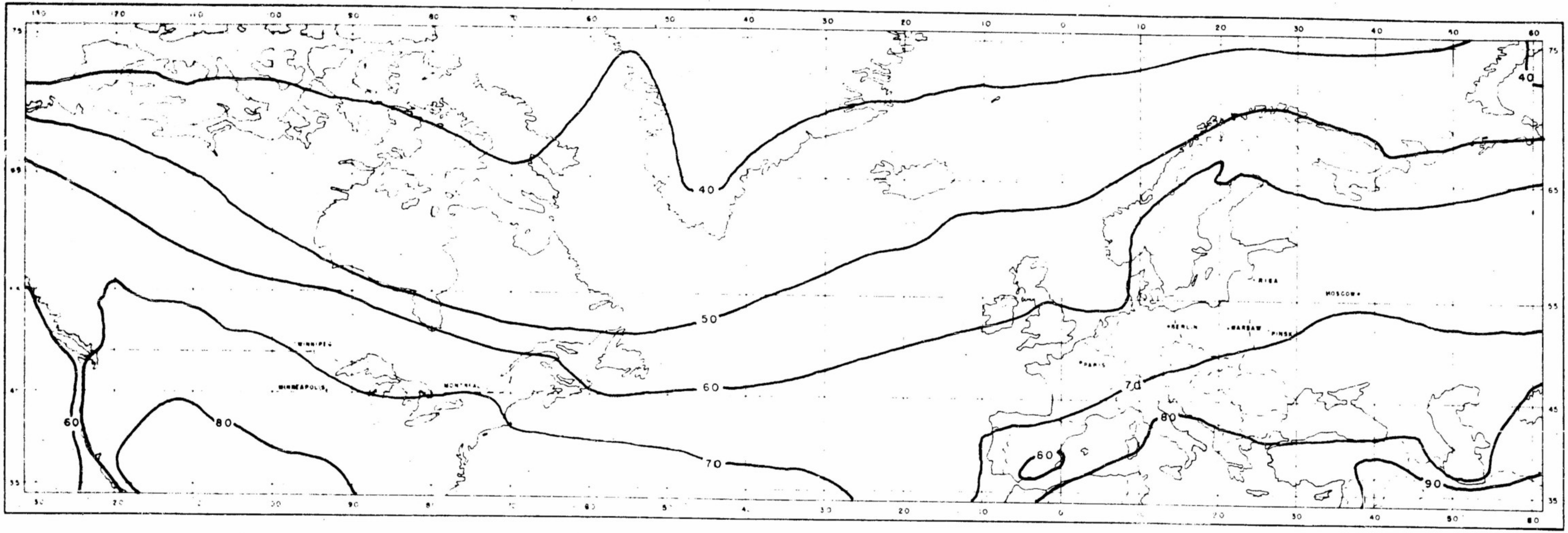
averages five. Map 22 shows the average frequency of thunderstorms for the six months April through September. It will be noted from the map, however, that the number of thunderstorms is slightly higher in the American than in the European area. Map 23 indicates the depth of snow cover. Since the American area is similar to that of the European area, only a map of Europe is shown. Likewise the snow cover map was not carried out for all the countries on the continent of Europe. Map 23 shows the generalized world tracks of cyclonic storms. It will be noted that one of the principal tracks across North America moves through the southern edge of the areas discussed in the previous chapters of this report. From this same map one will also note that one of the principal storm tracks crosses the Polish-Soviet area between Pinsk and Riga and heads toward Moscow. Accordingly one is not at all surprised upon examining Map 25 which shows the climatic regions of the world to find that the Minnesota area which has been studied in detail and the western part of the Soviet Union south of the Gulf of Finland are in similar climatic regions.

As shown by Map 26 both Northwestern Europe and the interior of North America are classed as plains regions. The lithic regions of these two areas, however, are different. In the Minnesota areas studied are found ancient crystalline and associated rocks in the eastern sections while to the west is an area of sedimentary rocks. In Europe, just south of Warsaw and Pinsk, is an area of ancient crystalline and associated rocks but around it is an area largely made up of unconsolidated sediments. Both the European and the American areas have been



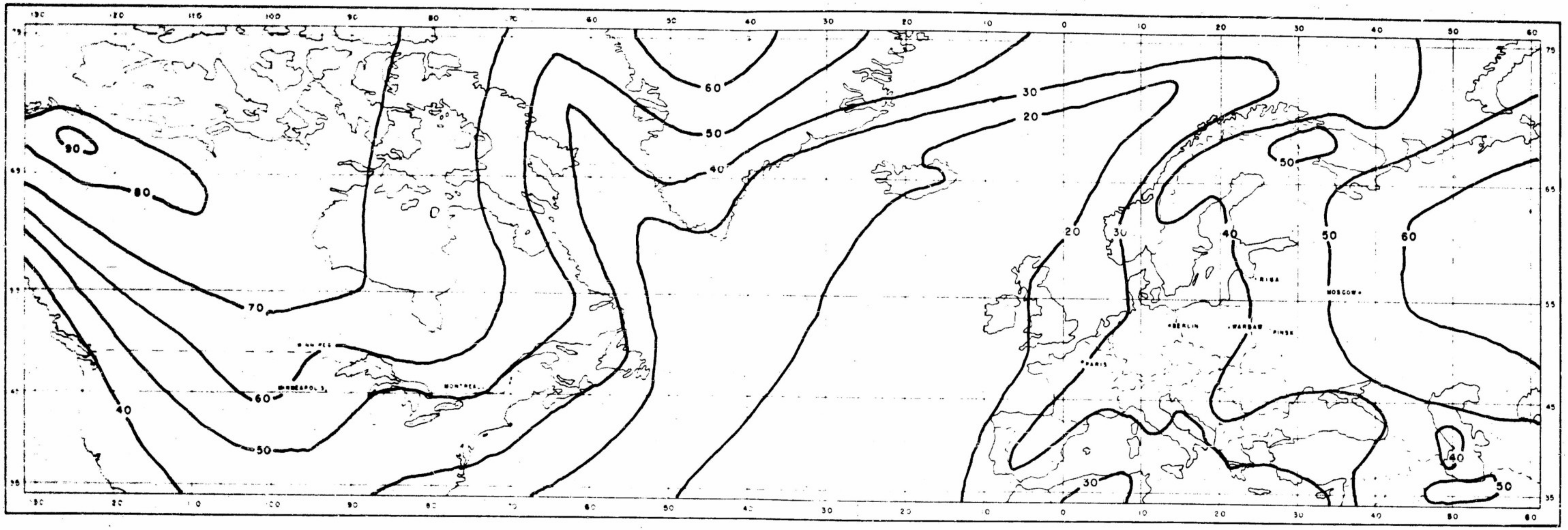
(Haurwitz and Austin)

Map 16 - Mean Sea Level Temperature for January (Degrees Fahrenheit)



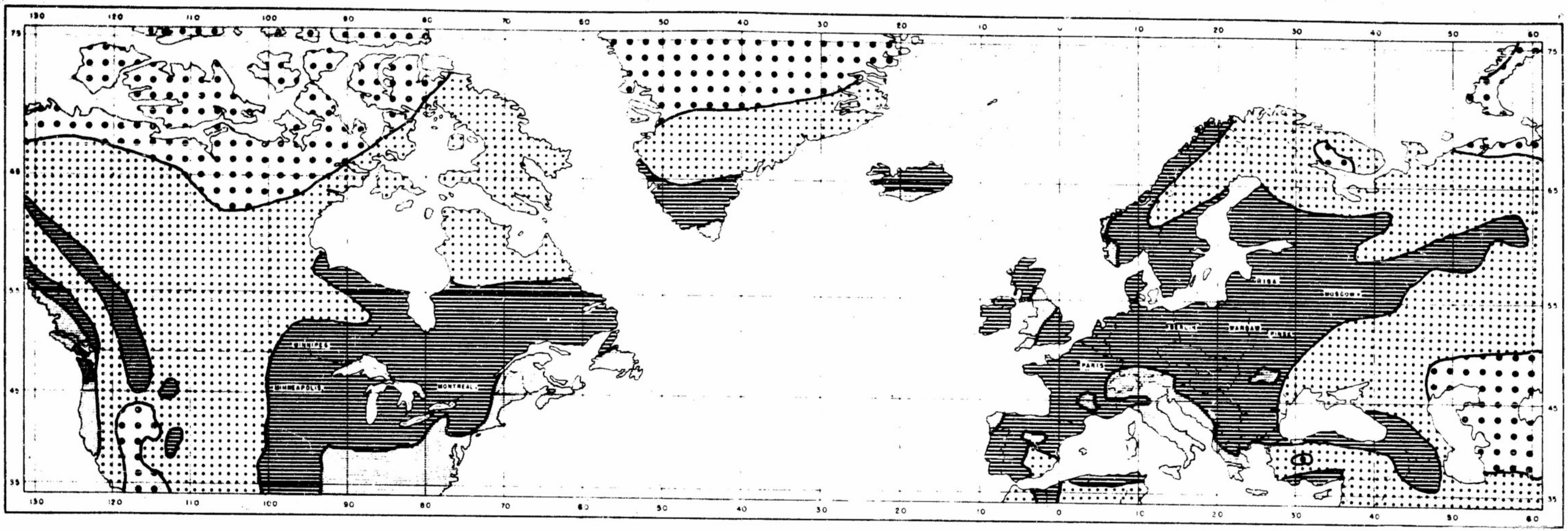
(Haurwitz and Austin)

Map 17 - Mean Sea Level Temperature for July (Degrees Fahrenheit)



(Haurwitz and Austin)

Map 18 - Mean Annual Temperature Range (Degrees Fahrenheit)



(Haurwitz and Austin)

Map 19 - Annual Precipitation

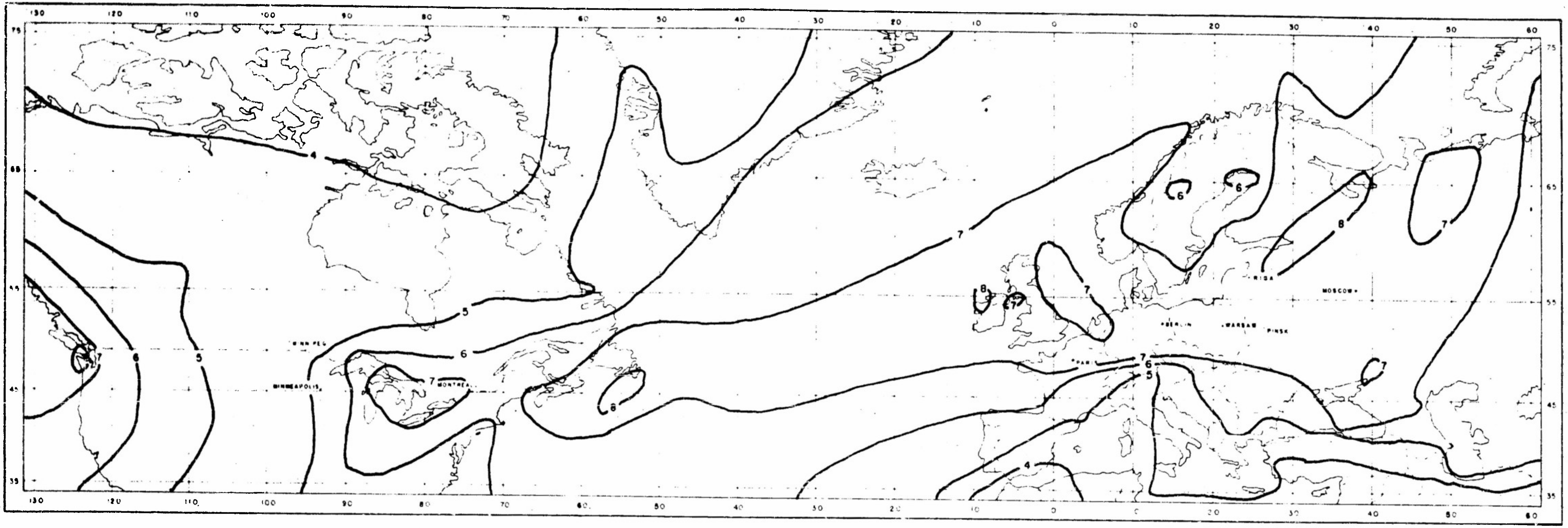
Under 10 inches

20 - 40 inches

80 - 100 inches

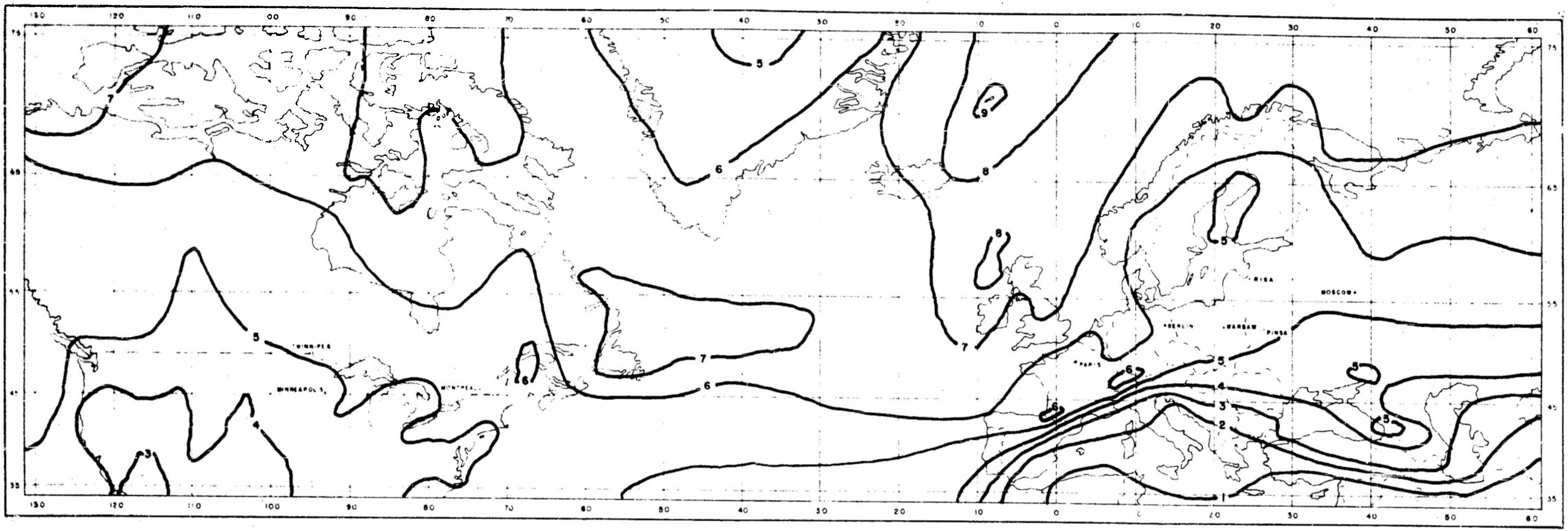
10 - 20 inches

40 - 80 inches



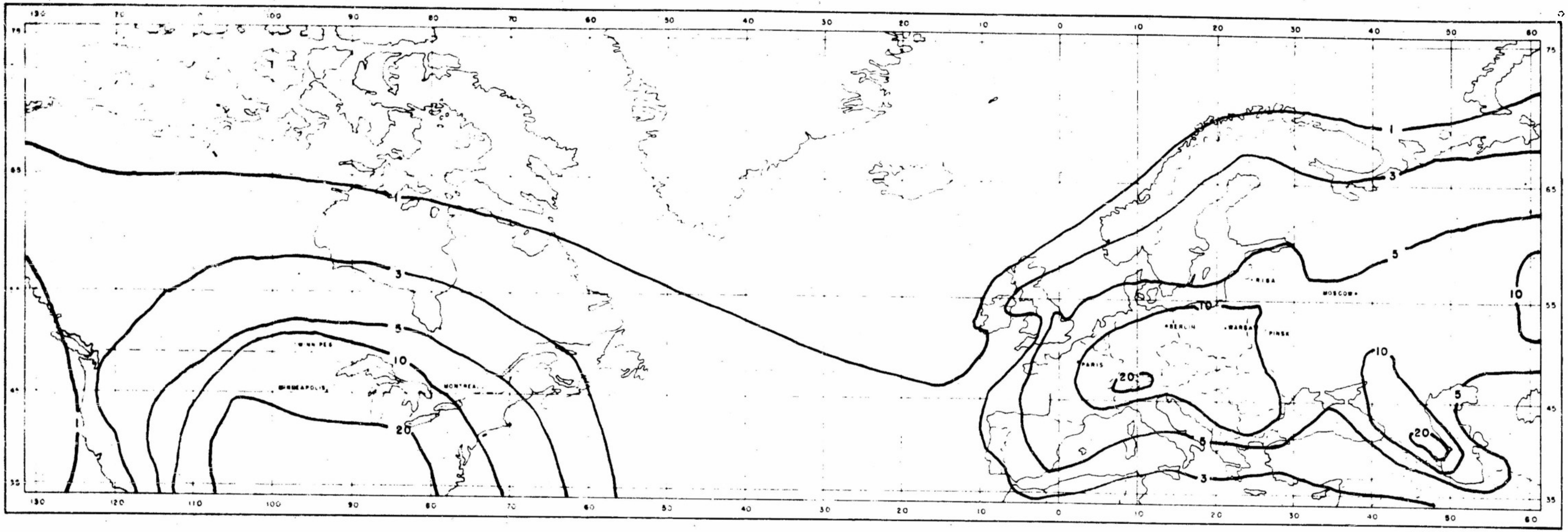
(Haurwitz and Austin)

Map 20 - Average Number of Cloudy Days in January



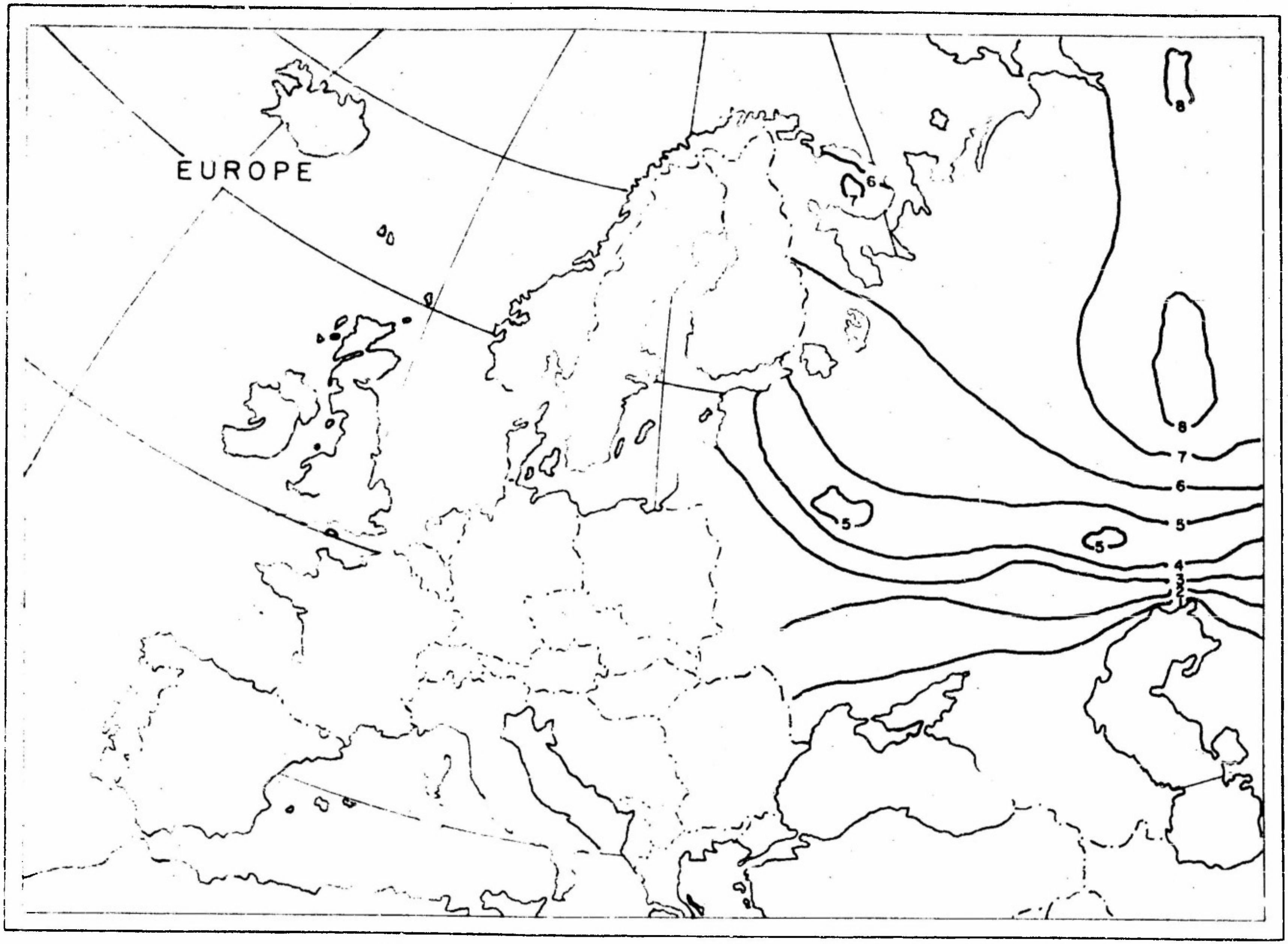
(Haurwitz and Austin)

Map 91 - Mean Cloudiness in July



(Haurwitz and Austin)

Map 22 - Average Frequency of Thunderstorms from April to September

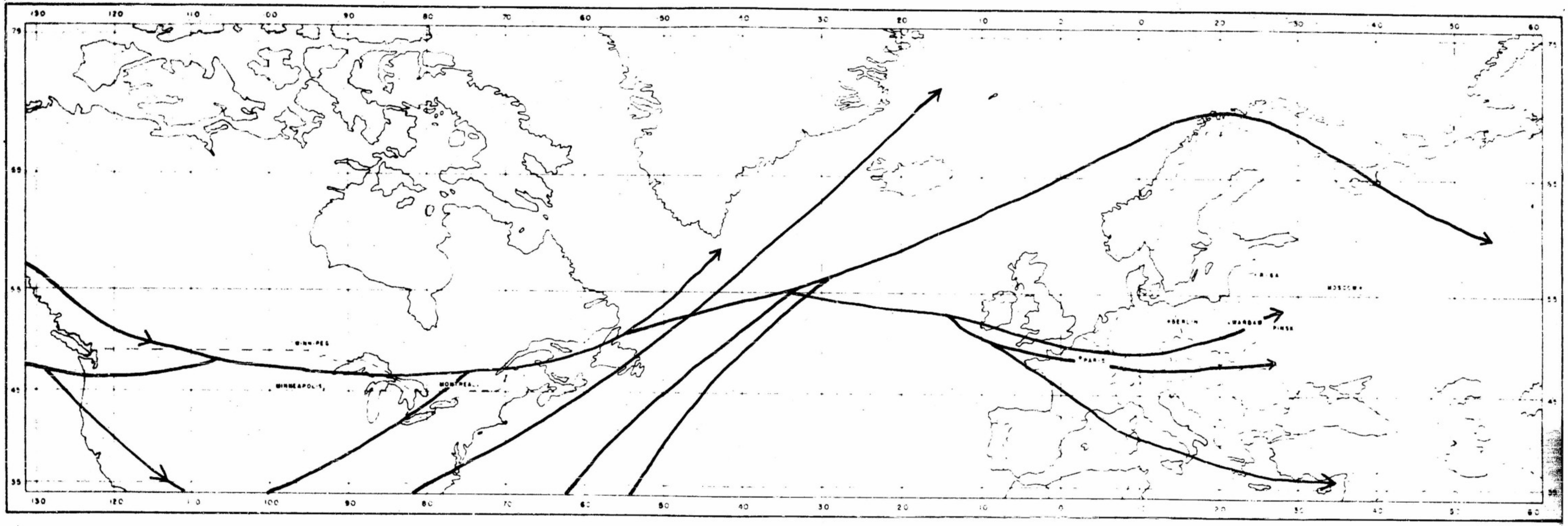


(The Great Soviet World Atlas)

Map 23 - Average Depth of Snow Cover in USSR

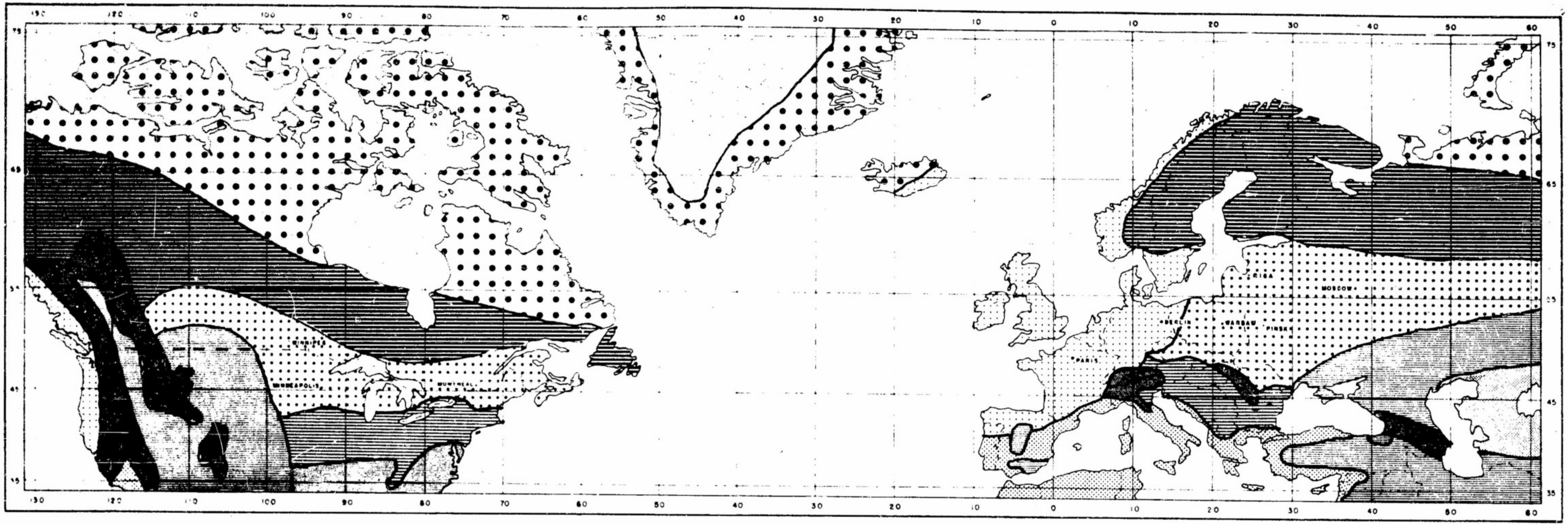
In inches for a decade with greatest cover each year.

1 = 3.94 inches	4 = 15.74 inches	7 = 25.54 inches
2 = 7.87 inches	5 = 19.68 inches	8 = 31.50 inches
3 = 11.41 inches	6 = 23.62 inches	



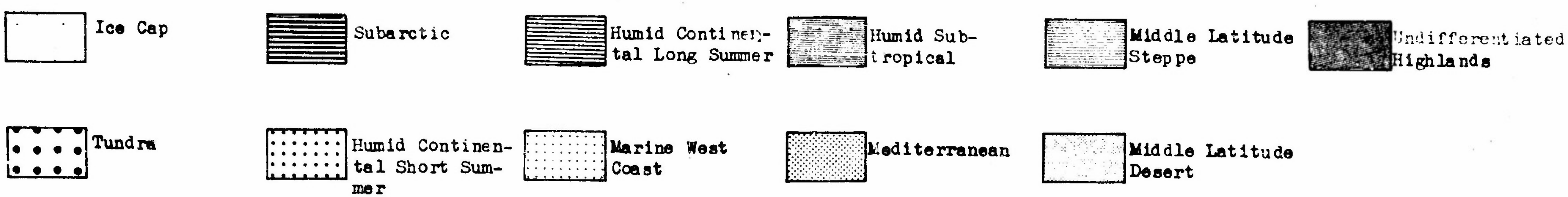
(Glenn T. Trewartha)

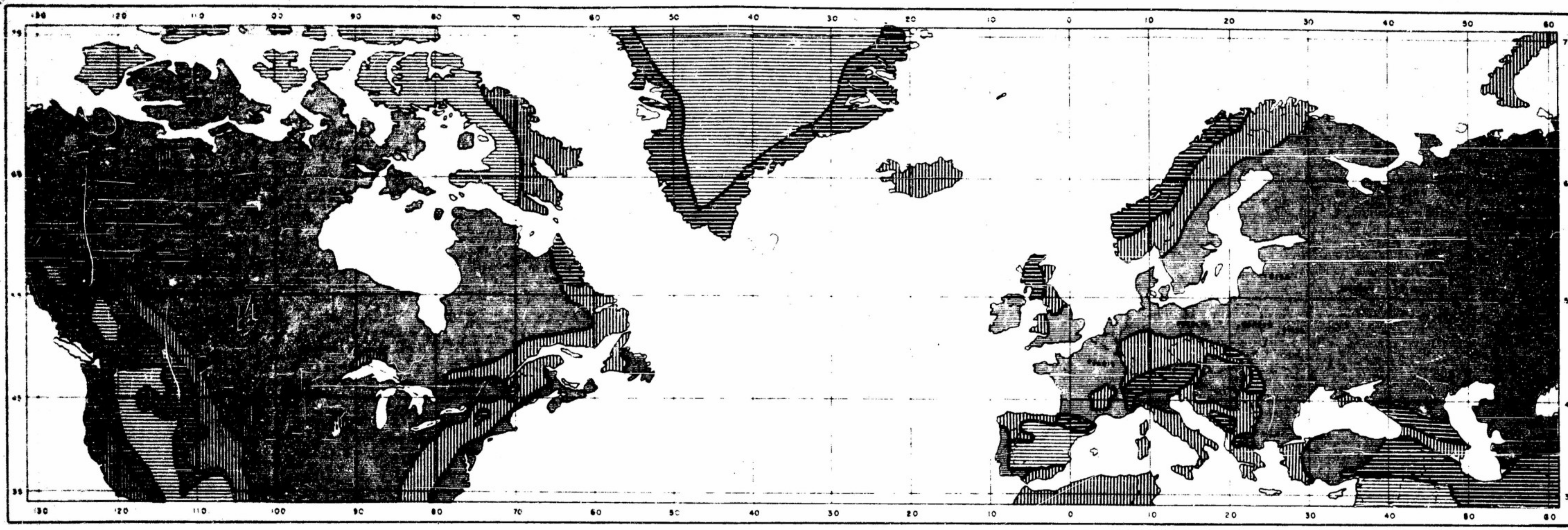
Map 24 - Generalized World Tracks of Cyclonic Storms



(Finch and Trewartha)

Map 25 - Climatic Regions





(Finch and Trewartha)

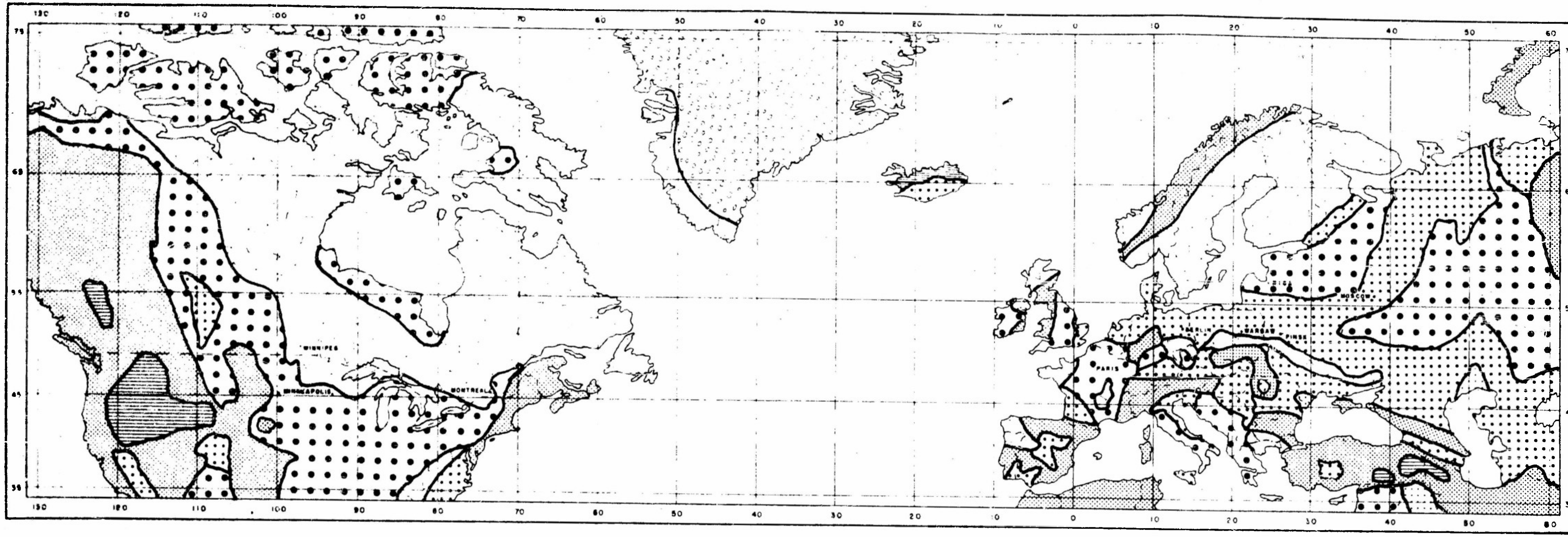
Map 26 - Principal Classes of Land Forms

Plains

Plateaus and Tablelands

Hill Lands

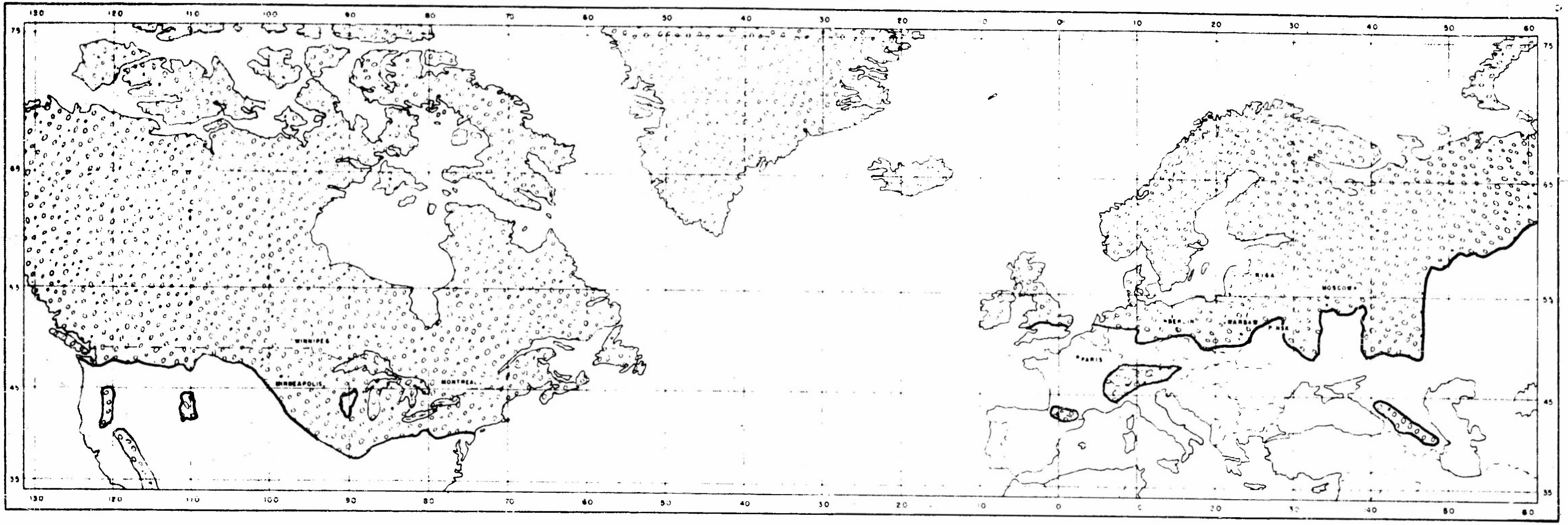
Mountains



(Finch and Trewartha)

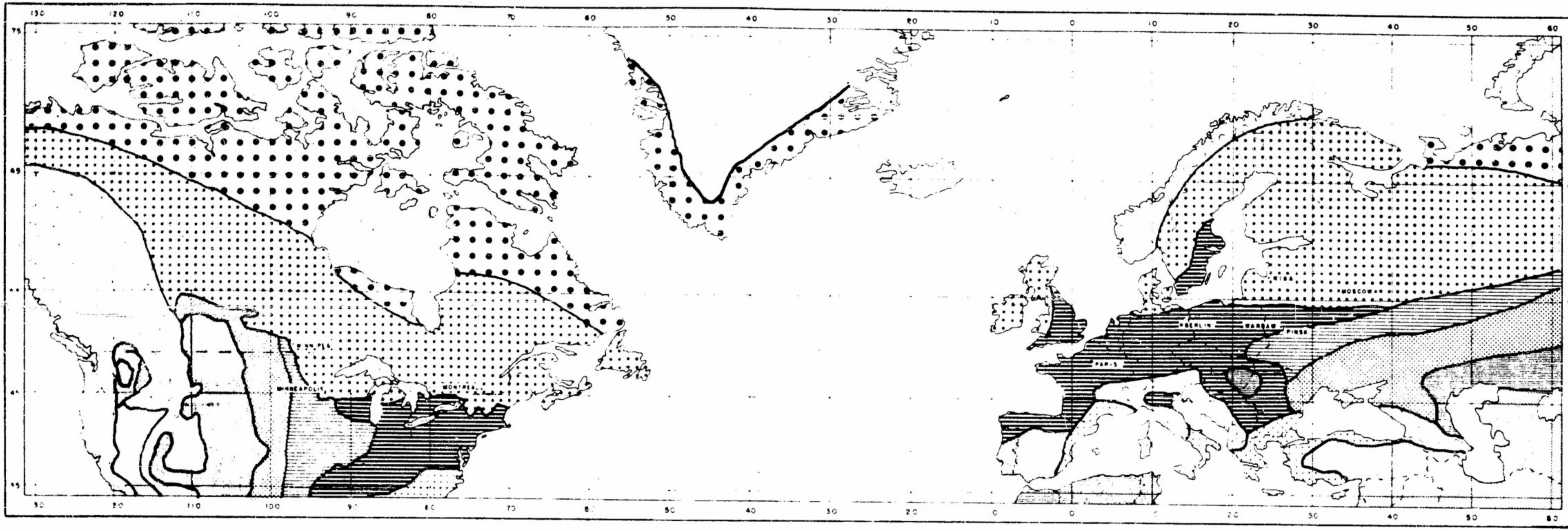
Map 27 - Lithic Regions

- Ancient crystalline and associated coarse-grained massive rocks of more recent age.
- Sediments, unconsolidated or but little consolidated.
- Fine-grained, glassy or ashy igneous rocks.
- Ice cap.
- Sedimentary rocks, well indurated, in most places but little disturbed.
- The larger areas of recent alluvium.
- Mixed rock types, intermingled, broken, no one type predominant. Mainly areas of complicated folds and faults.



(R. F. Flint)

Map 28 - Maximum Extent of Areas Glaciated During the Pleistocene



(Finch and Trewartha)

Map 29 - Soil Regions

Tundra soils

Podzols

Prairie soils

Brown steppe soils

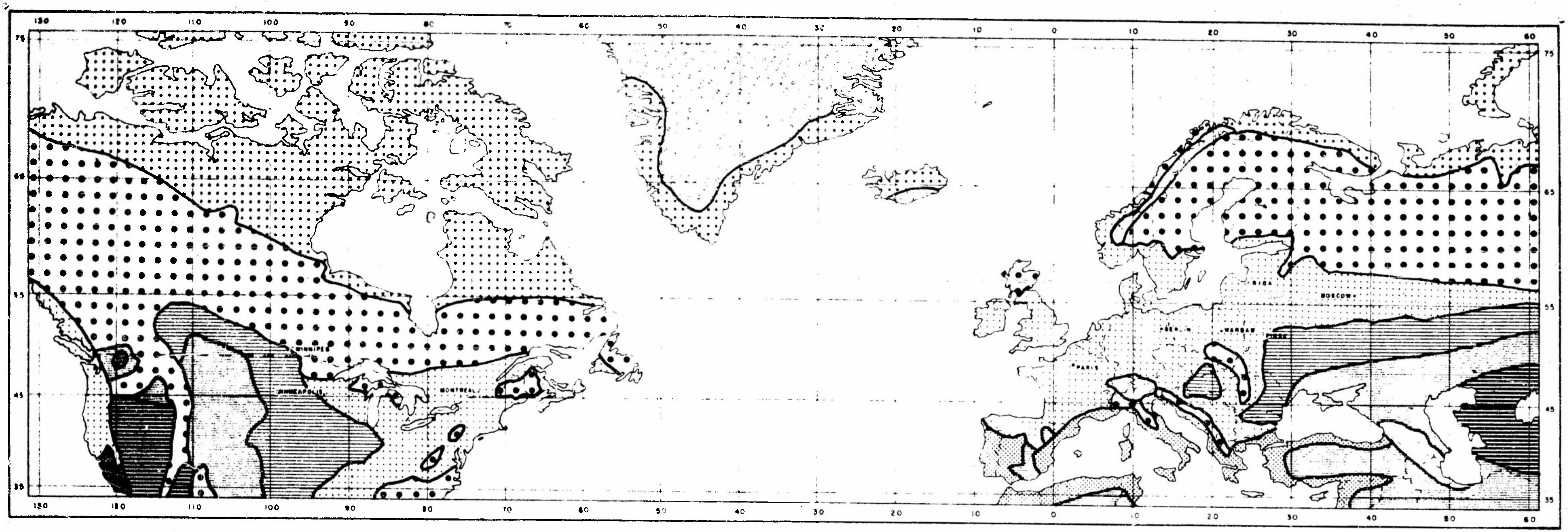
Desert soils

Complex soils of mountains and included valleys

Gray-brown forest soils

Chernozem soils

Tropical and subtropical red and yellow soils



(Finch and Trewartha)

Map 30 - Original Natural Vegetation

Coniferous Forest

Savanna

Prairie

Ice Caps

Broadleaf & Mixed Broadleaf-Coniferous Forest

Desert Shrub and Waste

Tundra

Mediterranean Scrub Forest

Undifferentiated Highlands

Steppe (Tropical in Middle Latitude)

glaciated. Map 28 shows the maximum extent of these glaciated areas during the Pleistocene period. In North America as indicated on Map 29 the soils of the area studied are classed as podzols, while in Europe they are divided between the podzols and the gray-brown forest soils. Along the western edge of the Minnesota sections studied is a region of prairie soils. The prairie soils are also adjacent to the podzols and gray-brown forest soils in Europe. Map 30 shows the original natural vegetation in the North American areas. This vegetation is in the overlapping zone between coniferous forests, broadleaf and mixed broadleaf-coniferous forests, and prairies. Although the arrangement in Europe is not quite the same as that in North America the zone of overlap is present.

The European countries wholly or partially located in the similar areas of Europe are Southeastern Finland, a part of Eastern Poland and the Soviet republics of Estonia, Latvia, Lithuania, White Russia, the Ukraine and Russia. Parts of Finland, like the Ely Area, consist of hard crystalline rocks and thus differ considerably from the rock of the countries south of the Gulf of Finland and adjacent to the Baltic Sea. In many places in Finland these rock outcrops are largely exposed especially on the coast of south Finland. Owing to the hard crystalline rock the morainic deposits are rich in boulders. For this reason stony ground and single large boulders are a common sight in forests and even in the midst of fields especially in Eastern Finland where fields have been cleared on hill tops. The character of the Finnish vegetation is determined to a large extent by the lakes and the soils as well as the

climate. In the central districts where the portion of tillage is generally smaller than in the coast areas the briefest glance from any height will show the tilled area to be no more than an occasional oasis in a desert of forests. The predominating tree species is conifers sometimes mixed with broadleaved species such as birch and alder. Here and there, especially near water or on moister land, pure birch stands may occur. The lakes are often bordered with alders beyond which rise slopes covered with conifers. Swamps as well as forests cover large areas of Finland. It has been estimated that one-third of the total land area is in swamps. Open, treeless swamps, however, which occur oftener in the north than the south of the country, are rarer than the afforested type consisting of moors with a growth of scattered pines and spruce. Swamps of the latter type are fairly common.*

Mr. Gunnar J. Viikinsalo in a letter to the writer makes this statement: "But-despite many differences quite possible, if you take a sleeping Finn, put him on a Minnesota swamp and wake him up there he probably believe to be in his own country. How long he would believe so, that is hard to say. You see, there are many likenesses, also there are many differences."**

Another letter, from Mr. Jaakko Peraaho also compares the southern Finnish swamp area with that in Minnesota. In Finnish swamps the following plants are common: Kanerva (Galluna vulkaris), Vaivaiskoivi (Betula nana), Suapursu (Ledum palustre), as well as berries. In Finland

*Leiviska, Iivari, Guide to Finland, (Helsinki, Lauri Levamaki, 1938), pp. 10, 11, 14, 15.

**Letter from Gunnar J. Viikinsalo, Box 370, Parkville, Minnesota dated October 7, 1953. Mr. Viikinsalo is a recent emigre' from Finland.

the cranberry does not grow in swamps, only on dry lands where it grows in bunches. The soil of the swamp in Finland looks the same as the soil of the swamp here (Minnesota).*

In the Baltic states of Estonia, Latvia and Lithuania will be found some areas that are similar to those studied in Minnesota, especially would this apply to the similarity between the Hubbard and Itasca Areas and some of those found in Eastern Latvia. In this small country terminal moraines are common in the province of Latgale.

Mr. Bakuzis, who was formerly Chief Forester for the Republic of Latvia, writes as follows:

> Some of these landscapes (Minnesota area) are to some degree similar to those in Latvia. The bedrock lake areas resemble Finland more nearly. The Baltic states, West Russia and Poland differ from Minnesota mostly in having less continental climate. The closest agreement to the landscape probably for the Minnesota regions would be found someplace between Latvia and Moscow.**

In a series of maps which Mr. Bakuzis is preparing for use in a publication, he shows in detail the morainic area of the province of Latgale and indicated that there was a distinct resemblance between this area and the Hubbard Area.

Two of the best references dealing with material inside the USSR that are suitable for comparison purposes with the present study are the book by L. S. Berg, "Natural Regions of the USSR" and Volume 5 of "Géographie Universelle" by P. Carmena D'Almeida. Berg makes the following statement which is just as applicable to the bogs and swamps of

---

*Letter from Jaakko Peraaho, 210 Second Avenue N. W., Chisholm, Minnesota, dated October 7, 1953. Mr. Peraaho is also a recent emigre' from Finland.

**Letter from Egolfs V. Bakuzis, Graduate Student, School of Forestry, University of Minnesota, St. Paul, Minnesota, dated August 10, 1953.

Minnesota as it is to those in the Soviet Union.

Bog constitutes a very prominent element in the landscape of the Forest zone. Bogs are particularly numerous in the taiga of Northern Europe and West Siberia.....According to the manner of origin, two types of bogs are distinguished - those which are formed by the growing over of basins (lakes and rivers), and those which are formed by the water logging of dry land.

When lakes become overgrown there takes place a gradual filling in of the basin with peat, and the transformation of the lakes into sedge or herbaceous bog, and with the passage of time, into sphagnum bog.

The water logging of dry areas is a very common process in the north of the USSR and in Scandinavia. Forests are particularly subject to this process. In the spruce forests, and sometimes also in the green moss and pine complexes, water logging is initiated by the appearance of the moss Polytrichun commune (common haircap moss) or of sphagnum mosses. Sphagnum is characterized by its capacity to absorb large quantities of moisture. Sphagnum peat is highly impermeable to water so that thick layers of peat constitute water-resistant strata. Both of these properties of sphagnum moss promote water logging. Soon after sphagnum water logging begins, spruce disappears, and the forest changes into pure pine. Then the pine itself begins to grow poorly. Ultimately the pine or spruce forest changes into a sphagnum bog with scotch pine. Often the water logging of an area begins after forest fires or felling in sections which were formerly dry. Forests which evaporate an enormous quantity of moisture lower the level of ground water in flat areas and help keep them drained. With the disappearance of the forests, ground water appears on the surface.

On sphagnum peat bogs, in the first stage of their development, scheuchzeria (Scheuchzeria palustris) predominates. This is the scheuchzeria peat bog, the wettest of all sphagnum peat bogs. It is almost impossible to walk across it, as there is standing water under the loose moss cover. With the passage of time, the peat moss gradually fills the watery horizon, and the bog becomes somewhat drier and passes on to the next stage, that of the sheathed-cotton-sedge peat bog. In addition to the sod of the sheathed-cotton-sedge (Eriophorum vaginatum), there are many evergreen under shrubs.

Three types of bogs are distinguished: (1) lowland or hypnum and herbaceous bogs; among these are sedge, reed, bull rush, reed-grass, and horse-tail bogs; (2) transitional or forest bogs with sphagnum as well as hypnum; among these there are shrubs, alder complex,

birch complex, birch and spruce, and birch-aspen-coniferous bogs; and (3) sphagnum bogs.*

One of the most extensive works on the Soviet Union that is available at the present time is the one by P. Carmena D'Almeida. This volume, written in French, gives an extensive survey of the Baltic states and Russia. For any person making an intensive study of this area he certainly must digest all parts of this volume. The following extracts are translations from his work:

> It is in the north and central part of Russia, where a cool and damp atmosphere predominates, that the peat marshes and the lakes bordered with peat bogs are limited. Only there, in the pure waters filtered by sand or limestone the sphagnums or peat mosses develop--mosses with growth enough to cause the development of peat on decomposing. These marshes occupy vast areas of the tree zone; one recognizes their presence by the stunted aspect of the trees, the growth of which is impeded by the excessive and persistent dampness; these marshes are often fearsome quagmires, where man and horse risk being swallowed up. On the other hand, on the flat elevations where they stretch out, these marshes represent invaluable reserves of water for feeding the rivers, the system of which would be endangered if man were to reduce too greatly their extent. That (providing water supply for rivers) is not the limit of their utility.
>
> The southern limit of these peat marshes, in the region of the Volga, reach to the vicinity of Simbirsk. Lake Svêtloe, 53° 21' N. latitude, is bordered with a fringe of marshes at which the presence of peat mosses indicate its northern character, while nearby appears feather grass, a characteristic of the steppe of the south.
>
> There is no sudden passage from the tundra to the forest, no more than from the forest to the steppe, and the botanists distinguish a transitional zone to the north as well as to the south: the "forest tundra" on the one hand, and the "forested steppe" on the other. Of a variable width with numerous inflections, this intermediary zone is like a land of combat between the two formations which it separates.

*Berg, L. S., <u>Natural Regions of the USSR</u>, (New York, Macmillan, 1950) pp. 43-44.

The forest, which reflects the combined influence of the climate and the soil, does not undergo it in an entirely passive manner, for in its turn the forest acts on the nature of the soil which it covers. The podzol, easy to pulverize, of a whitish tint, corresponds to the zone of conifers to the north, in the country of cold and prolonged winters, in which the duration of the low temperature impedes evaporation; the moisture dragging down into the soil mineral elements from the surface, finally cause to develop in the subsoil the formation of an impervious layer, rich in iron, so that the podzol, quite unsuitable to cultivation scarcely lends itself to the existence of the forests, and the forest itself is broken up by heaths and peat bogs. The gray soil is that of the mixed forests, growing under a less severe climate, less humid, and more accessible to evaporation during the course of a warm season of a certain duration; its texture is no more easily pulverized, the humus is more abundant, and the marshes are no longer of the peat type.

The marshes are of two sorts: the marshes characterized by an abundance of rushes, reeds, sedge, water lilies, and the peat marshes. The first type is found in all of Russia; the peat marshes, particularly the sphagnum marshes, exist only in the North and in the Central, the numerous hollows in the terrain of a glacial region, the heights with flat portions where the water flows with difficulty are the preferred places of peat marshes, while the others occupy, rather, the small lakes without much depth on the abandoned arms of a river, whatever the nature of the subsoil or the purety of the water. The sphagnum requires pure waters, such as those that sand filters; very thirsty for water, it develops especially there where the atmosphere is humid and where the evaporation is not excessive. Thus provided with water by the soil and atmosphere the mosses develop, accumulate; the living plants grow above dead ones which are decomposing and forming peat. The peat bog may finally end by drying out, but there are cases where it extends itself, and it is then that it is a cause of falling back and destruction to the neighboring forests.

It is especially the pine forests which suffer from the presence of peat marshes. Their being close is marked by the sight of ailing trees, with the crown dried out or deprived of needles; the excessive moisture causes the roots to rot and the first sandstorm is sufficient to cause the pines to fall over. This suffering forest, in an unequal struggle with the marsh is the problem of the Russians, more inhospitable even than the dense and living forest. Walking is very tiring, for the foot mires up in the brown mass of peat in formation, or strikes against the trunks lying on the ground. This desolate landscape is so uniform that the traveler has difficulty in orienting himself, and the inhabitants of the country

themselves do not venture far into the marsh. It is enough that a few foresters come here from time to time only through professional obligation and that a few women and children enter a short distance to gather the mushrooms or huckleberries of the marshes. There is scarcely anyone except hunters accustomed to the area from their childhood who can find their way; the hunters note in passing the broken branches, notches on the trunks, rags attached to the trees, rare indications of the route that others would not notice.

One can conceive how the soft soil of the peat bogs would hinder communications. The great extent of these soils in the Northwest has made the construction of the great railroad from Leningrad to Moscow exceedingly difficult; the same is true of the construction of more recent lines across the forested zone of the North to Archangel.*

Much correspondence has been carried on with Mr. Vladimir Bereziuk, a displaced person from the Ukraine. Mr. Bereziuk lived in the province of Polesia and has written a fairly extensive paper dealing with the area. In many ways the descriptions are similar to those given in previous chapters. His paper is of interest from the cultural as well as from the physical point of view. Thus it is printed herewith as Appendix 3.

*Carmena D'Almeida, P., Etats de la Baltique-Russie, Tome V, Geographie Universelle, (Paris, Librarie Armand Colin, 1932) pp. 72, 77, 78, 79. (The above is a translation of pages 72, 77, 78, 79.)

Fig. 150 - European Larch growing in the Quetico-Superior Wilderness Research Center on Basswood Lake. The tree is a relative of the Tamarack. It is common in the Boreal Forests of Europe.

Appendix 1

Plant Successions

Botanists familiar with other areas along the southern edge of the Boreal Forest have worked out the following plant successions.

For lakes other than bog lakes which are acid, the succession would probably be as follows:

Reeds
↓
(Iris Association)
↓
Willow-Alder
↓
Tamarack-Black Spruce-Northern White Cedar
↓
Spruce-Fir
↓
Beech-Maple

The wild hay meadows, wire grass, and bluejoint areas are probably a result of disturbance by man. The following succession occurs after cultivation.

Weed Association
↓
Meadow Association
↓
Willow-Dogwood-Alder
↓
Tree Association*

From the work of Gates at Douglas Lake, Michigan, the probable succession from bog lakes to the climax forest, for the species in the areas, would be as follows:

*Rice, Dr. Elroy L., Assistant Professor of Plant Sciences, University of Oklahoma, Norman, Oklahoma

Reeds
↓
Cattails
↓
Sedges
↓
Leatherleaf-Labrador Tea
↓
Tamarack
(Dwarf Birch here probably)
↓
Black Spruce
↓
Northern White Cedar
↓
Balsam Fir
↓
Maple-Beech
(Birch, etc., also)*

*Gates, F. C., "Plant Succession about Douglas Lake, Cheboygan County, Michigan," Botanical Gazette 82 (1926), pp. 170-182.

Appendix 2

Table 7 - Brief Description of Forest Types of Latvia*

Upland Types

Name	Relief	Soil	Species	Ground Cover	Succession after cut or burn
Pinetum cladinoso-callunosum	Dunes or plain, microrelief level	Dry sand or gravel	Scotch pine, birch, few shrubs, juniper	Heath, cowberry, lichens	No change
Pinetum molin-ioso-myrtillosum	Drained plains or undulating in depressions, some hummocks	Moist to wet sand or gravel. Ground-water 3 feet and deeper	Pine, spruce, birch, aspen (spruce in 2nd story) some juniper	Berry plants, herbs, mosses (green)	Birch and spruce may replace pine
Pinetum-piceatum moliniosc myrtillosum	Hilly or undu-lating, the wet subtype on flats	Moist to wet sandy loam. Ground-water 4 feet and deeper	Spruce, pine, birch, aspen hazel, juniper, alder	Berries, ox-alis, other herbs, green mosses	Birch, aspen, white alder
Piceatum oxalidcso-myrtillosum	Hills, undula-ting, flat	Moist to wet sandy loam and loam. Ground water 3 feet and deeper	Spruce, birch, aspen, hazel, alder, mt. ash	Oxalis, other herbs, green mosses	Birch, aspen, white alder
Piceatum compositum	Hills or un-dulating	Moist, rich humus loam. Ground-water 4 feet and deeper	Spruce, birch, aspen, ash, lin-den oak, alders, elm, hazel, mt. ash, etc.	Herbs, ferns	Birch, alder, aspen

*Bakuzis, Egolfs V., formerly Chief Forester for the Republic of Latvia; present Graduate Student, School of Forestry, University of Minnesota, St. Paul, Minnesota.

Table 7 - Brief Description of Forest Types of Latvia (Cont'd)

Lowland Types

Name	Relief	Soil	Species	Ground Cover	Succession after cut or burn
Pinetum ledosum	Flats or depression	Wet, up to $1\frac{1}{2}$ feet, deep sphagnum peat on sand. Ground water shallow.	Pine, birch, few spruce	Half-shrubs, sphagnum, polytrichum	Birch
Piceatum aspidiosum	Low flats or valleys, hummocks	Wet sedge-hypnum-sphagnum peat on bluish loam or sandy loam	Spruce, birch, alder, aspen, ash, pine, some shrubs	On hummocks ferns, green mosses, herbs	Birch, alder
Alnetum glutinosum	Deep laying flats, river bottomland	Wet, decomposed woody peat on marl, loam or sand	Black alder, birch, ash	Herbs and ferns	Birch

Appendix 3

POLESIA - THE LAND OF GREAT SWAMPS AND MARSHES*

Landscape of Polesia

Polesia (Engl. woodland) is the greatest swamp country in Europe. This gloomy and dreary country embraces about 80,000 square miles and is very sparsely populated. One can travel for hundreds of miles through a landscape that seldom changes. The dark forest in the swamps alternates with the open marsh-meadows covered with pools. There are a large number of lakes, also small moraine-lakes. The solid islands are left-overs of moraines or sand-dunes.

The sands take in almost imperceptible rises of ground and form wandering or wood covered dunes.

These sandy rises of ground together with the elevated banks of some of the rivers, afford the only sites for human abodes. On yellow-white sand dunes stand a few log houses amidst wretched little fields and poor meadows, corduroy and bush roads stretching for miles which connect those small, very sparsely scattered human settlements.

Between swampy woods and moors the Prypyat (Pripet) River and its tributaries form a labyrinth of delicate, intricate waterways and stagnant pools.

At the time of the melting snows in the spring or of the heavy rains in the early summer, the entire district is transformed into an immense lake, above whose surface only the flooded forests and the settled sandy elevations of ground are visible.

Only the wooden windmills on those sandy elevations contribute to the variety of the landscape. A strange impression is made in the large ancient cemeteries by the high wooden crosses on each grave which mark the wide horizon.

At the time of the floods the few railroads and highways are blocked and certain places in Polesia may be reached only by water.

Geographical and Geological Survey of Polesia

If we look for Polesia on a map we find that it lies as the northern plain district of the Ukraine and Belorussia (White Russia) which directly joins the Polish lowlands, and indirectly, the North German lowland.

---

*Bereziuk, Vladimir, 131 First Street S. W., Chisholm, Minnesota

The morphological regions surrounding the immense flat basin of Polesia are (1) in the west Pidlassya Plains, (2) in the north the Belorussian Plateau, (3) in the east Polesia extends beyond the Dnieper to the spurs of the Central Russian Plateau, (4) in the south lies the Volhynian Plateau.

The bottom of Polesian basin is very flat and lies at a height of 390 to 490 feet above sea level. (Average elevation of Ukraine is 683 feet and of entire Europe 1089 feet.)

The main stream of Polesia is the majestic Prypyat River. Prypyat is a labyrinth of river branches, lakes, old river beds, swamps and fens. Its tributaries are the Stokhod, Stir, Horin, Ubort, Uz (on the right) and the Pina, Yassiolda, Sluch and Ptich (on the left).

The Prypyat gathers in all the waters of Polesia, its length exceeds 279 miles. Rising in the northern spurs of Volhynian Plateau, it immediately reaches the Polesian Plains and becomes a navigable river over 175-660 feet wide and about 20-30 feet deep.

The grade of the river is very slight; the difference of elevations between its source and its mouth amounts to only 100 feet. Its tributaries have also the character of genuine lowland rivers. All these rivers flow very slowly and deposit the mud which they bring from the plateau regions surrounding this country.

By this means, they raise their beds and their banks more and more, so that all these Polesian rivers flow upon flat dams. At the time of high water, the rivers overflow their banks and flood the entire lowland far and near.

The substratum of Polesia is composed of chalk marl, while in the east oligocene formations also appear. But this substratum is very seldom seen, all the rest of the country being covered with diluvial and alluvial sands and great swamps.

The glacial periods were of great importance for the surface configuration of Polesia. The traces of glacial period, boulders and rubble of Scandinavian origin are frequently met in southern Polesia.

The water from Baltic glacier flowed off through the region of the present Polesia and formed a large lake with the Dnieper as its outlet. The lake was then gradually filled in, the northern and western tributaries bringing more sand, the southern ones mud.

At the same time the Prypyat River cut in more deeply, and was, therefore, constantly more able to carry the waters of Polesia to the Dnieper River. Thus swamps have taken the place of the land and have gradually covered the entire land. The many smaller lakes of the region

are the only remains and proofs of the one-time great lake. Many tales are told by the inhabitants of Polesia about the small marsh lakes being bottomless. But exact measurements have shown that they are not deep and lie at a higher level than the rivers. During the flood periods, the rivers have often sought new beds, and this explains the frequency of old river beds and river branches, which are peculiar to all Polesian river courses.

The spring floods last about two months, the summer floods about two weeks. These periodic floods are the main cause of the continuance of the Polesian swamps. At the time of the high waters Polesia reminds one of prehistoric times.

Flora

Polesia is one of the most remarkable forest regions and in a few districts of this country we can still see what the primeval forests were like.

In the west and north of the region predominate great peat moors with woods; in the south and east treeless marsh-meadows overgrown with willow brush.

In respect to flora, this region possesses only a few endemic species. After the withdrawal of the glacier the forest flora had immigrated from Central Europe and Siberia. Since primeval days, only a very few natural changes have occurred in the vegetation of Polesia.

Also, man through his cultural activity has worked few changes in the plant world of this country. Only very scant sections of the region are used for farm land.

We find here several plant formations with special tree, bush and shrub species and with special herb and grass vegetation.

Typical Plant Formations

1. Pine Wilderness (latin: Pineta)

The predominating species of tree is the pine, which forms large woods everywhere on sandy soil; the birch always accompanies the pine.

Bush, shrub and herb vegetation:

Calluna vulgaris
Vaccinium myrtillus
Vaccinium vitis idea
Arctostaphylos uva ursi

Pirola uniflora
Pirola secunda
Chimaphiba umbellata
Azalea pontica

2. Querceto - pineta

The oak and pine. There is an admixture of a considerable number of alder (alnus glutinosa) on the swampy ground.

Herb vegetation richer. Lot of Pteridium aquilinum.

3. Carpineto - pineto

Pine, oak, linden (Tilia cordata), hornbeam, hazel bushes
Pteridium aquilinum, black raspberries and Pubus saxatilis

4. On dry small islands surrounded by swampland

Oak, ash, linden, maple, hornbeam, hazel bush
Nice smelling: Asarum europeum

5. Alnetum - on the swampy ground

Alnus glutinosa with admixture of birch
Athyrium felix femina
Aspidium spinulosum
Urtica dioica
Solanum dulcamara

6. More wet conditions as in the Altenum formation. Mostly Betula pubescens, Betula humilis

Carex
Calamagrostis lanceolata
Eriophorum vaginatum

7. Carex - swamps

Also Calamagrastic lanceolata, fern

8. Carex and hypnum formation

Willow and Betula pubescens

9. Carex and sphagnum formation

Salix lapponum, Salix cinerea

10. Sphagnetum formation

Sphagnum fuscum
Ledum palustre
And very small species of pine tree

11. Typical clearings vegetation

Nardus stricta
Deschampsia, caespitosa

In old river beds are growing Juncus, Typha, Phragmites and Salix viminalis. In some places are Rhamnus and Evonymus etc. Once in a while a few Rhododendrum flavum. I have seen growing here a species of the juniper tree, one foot in diameter. In some places in Europe, we can often find juniper as brush species or dwarf species.

<u>Fauna</u>

Prevalent animal species vary only slightly from those found in neighboring countries in the West. Worthy of mention are moose, deer and some beaver colonies. Bear are very rare. Of the cat family only the lynx is found. Wild boars wander in great herds. There is also Marte Martes, L.

Also the bird world is very numerous.

Tetrao urogallus L.
Tetrao bonasius L.
Parus ater L.
Parus cristatus L.
Turdus musicus
Carduelis spinus L.
Dryosopus martinus L.
Ciconia nigral
Emberizza schoenikelus goplanae Dam.
Milvus milvus L.

In this country we find an interesting amphibi: Lacerta vivipara Jacg.

There is also an abundance of fish: Pike, tench, carp, crucian, shad, anguilla fluviatilis, salmo salar, Gobiidea, petromyzan fluviatilis etc.

<u>Polesian Climate</u>

The termal conditions of Polesia assume an entirely independent

position. We can call it as the province of boreal climate, which is favorable for the growth of forest plants.

The difference between the mean of the coldest and that of the warmest month is 24°C. or 92°F. The winter is not too severe; the frost period extends over four months. The sloppy weather of spring consists of a constantly varying succession of frost, thaw, snowstorms, rain and sunshine ending usually in the middle of April. The actual spring usually lasts four weeks through the entire month of May. The summer is moderately warm 18°C. or 90°F. The fall is regularly very beautiful and comparatively warm. The moist autumnal weather which begins the transition to winter lasts as long as two months.

West winds prevail, bringing Atlantic air, which mitigate the frosts and cause precipitations of rainfall.

Polesia is seldom reached by the east winds, which are accompanied by heavy frosts. The humidity of the air is great. The light night and morning fogs appear especially in the fall. The greatest number of cloudy days occur in this part of Ukraine. Polesia is rather poor in rainfall. The heaviest precipitation is in July, since in those regions of forests and swamps evaporation is heaviest at this time due to the heat. Hailstorms are rare. The climate of this district has not been studied to any great extent. In the entire territory there was not a single metereological observation station. Years ago, the French geographer, de Martonne investigated the climatical conditions of the entire Ukraine and set it up as one of the types of climate of the globe.

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As a result of the decided preponderance of forest and swamp areas, agriculture in this district takes a back seat and confines itself only to the small number of higher and more fertile places.

It is true, since the beginning of the twentieth century, that the Russian government and after World War I the Polish government have been working to drain the swamps and reclaim them for civilization. In both cases Ukraine was a battleground for Germans and Russians, for Poles and the Ukrainians (1917-20) and again for the Germans and Bolsheviks and consequently, the draining projects never materialized. In other European countries experience has shown that such lands are eminently adapted for producing good crops of vegetables, forage crops, and grains, in so far as the climate permits.

Agriculture in this district is still on a very low plane. Old traditions are preserved in connection with agricultural implements and habits. Oats take up 21 per cent of the Polesian farmland, barley 6 per cent, buckwheat 7 per cent, beans and lentils 2 per cent. Only 6 per cent of the farmland consists of potato fields. But in the wet fields

above the Prypyat the flax produces silk-like fibres and therefore, the finest linen in the Ukraine. Hemp is also cultivated. All the hemp products were used in home industry, while the flax products were mostly exported. Hemp and flax are cultivated also for the sake of oil.

Vegetable gardening is only slightly developed. Beyond the little vegetable gardens about the homes, we don't see the cultivation of vegetables on a big scale.

Cattle raising is of great importance in the life of the Polesian people. Dairying in Polesia has hardly begun. The native hog breed (black hog) is very easy to fatten. Besides farm breeding, extensive breeding of hogs is carried on in Polesia. Large droves of swine live in the oakwoods during the fall. Small farmers also breed a coarse-wooled native sheep. Poultry raising constitutes one of the most important sources of income for the peasants.

The peasant horses, despite their unseemly outward appearance, are really suited for the rough roads of their land.

The original forest bee culture is very important.

Although there is a closed season on fishing, it is never enforced and hence there is no longer an abundance of fish. Hunting is common and it is more or less an avocation for the people who live there. There are a lot of boar, and deer who cause considerable damage to the fields.

The Polesian people are good at all crafts, especially at woodwork, carpentry, turnery and rope and net making. Weaving and furrier-work and tanning are widely practiced. Cooperage is very common also basket weaving which is developed to a high degree. The shingle industry, charcoal burning, pitch and potash-making, are native to this region.

Utilization of animal raw-materials, oil pressing, mead brewing (honey boiled with brandy, a national beverage), is common.

The food of the peasants is almost vegetarian and consists of bread, vegetables and milk. The menu is not monotonous. Meat is eaten, but very little in view of their truly Spartan mode of life. Poultry and hogs being sold to the dealers or in the cities on the countless fair days is common to this district. These fairs are a hold-over from medieval trading days.

The city of Pinsk carries on the great lumber trade in this region. It is an important river port, has large sawmills and ship building industries. The waterways of Polesia can be very important roads of trade and commerce. Some existing canals in this region are antiquated, shallow and neglected.

Roads in this region are mostly cane and corduroy roads which are a positive torture for any traveler. Some of these roads are among the worst in the world. In the summer they are enveloped in clouds of dust; in the spring and fall, as well as in the rainy season, they are strips of bottomless mud, in which even the light farm wagons sink to their axles.

Large peat deposits are widely distributed throughout Polesia and it was cut on a large scale. Peat is very important for some districts of the Ukraine and is used as fuel. Swamp iron ores were found but not exploited.

This is not the place to discuss at any length the economic conditions of this region. We are only emphasizing the facts. The future opportunities of this land are unlimited and lie in the use of agriculture, forestry and the industrial opportunities.

The people of this country are the north-western frontiers of Ukraine.

Only to these Polesian forests does the Ukrainian nation owe its preservation during the Tartar attacks. The forests and swamps afforded the only refuge for the people because of the difficulty of crossing or invading this area. To the forest went the people of the Steppes whenever they were threatened by the nomads, moving back again at a favorable opportunity.

These people show traces of ancient culture; their language is still medieval in comparison with the pure (high) Ukrainian. There are rich sources of ancient Ukrainian folklore.

The movement in the population of Polesia is as follows: natural increase per thousand and per year, birth 39.4, mortality 17.7, actual increase 19.4.

This ancient ethnic group was kept for centuries from modern civilization by the strong hands of the Russian and Polish governments. Historico-political tradition is not as rich as other sections of Ukraine, but they have their own sacrifices and heroes, their own historical griefs and joys.

As in previous periods of Ukrainian history, they fought under the Grand Princes of Kiev against Asiatic hordes as in the 17th and 18th centuries under Hetman Khmelnytsky and Mazeppa against the Poles and Russians, also in the last few years in a new liberation movement against the German and Soviet invaders.

Geographically these lands are very suitable for underground resistance. The greatest dream and ambition of these forgotten people of Europe

is the day of national resurrection, when they can hear again the ringing of their bells from the churches of "Ukrainian Jerusaleum," their holy Kiev.

United with the free Ukraine of the Steppes and backed by its vast rescurces Polesian country has an opportunity on the road of progress.

Fig. 151 - Typical Polesian swampy wood.

Fig. 152 - A small Polesian River. On the left is a moss sphagnum formation. The ground is very soft and it would be unusually difficult to walk upon. To the right is an Alder grove.

Fig. 153 - A typical "Sander" (Icelandish term) landscape. In the foreground is a sandy area which is the remainder of a ground moraine. To the back is a lowland peat area.

Fig. 154 - A typical moraine landscape.

Fig. 155 - A Polesian log house with straw roof and brush fence around the yard.

Fig. 156 - Polesian cemetery. The tall wooden crosses are typical of cemeteries in the marsh area.